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THE TREATMENT OF LARGE MYOMATOUS TUMORS OF THE UTERUS.

MYOMOTOMY AND HYSTEROMYOMECTOMY.

By HOWARD A. KELLY, M. D.,

Gynecologist and Obstetrician to the Johns Hopkins Hospital, and Professor of Gynecology in the University.

(READ AT A MEETING OF THE JOHNS HOPKINS HOSPITAL MEDICAL SOCIETY, MARCH 2, 1891.)

I have here four large myomatous uterine tumors, my most recent myomotomy and hysteromectomies. Each of the specimens is pretty nearly the size of a pregnant uterus in the latter months (*v. Fig.* 1); when in the abdominal cavity they closely simulated the protuberant stomach of advanced pregnancy, even to the degree of necessitating some of the women harboring them to change their gait and find a new equipose for the body with the shoulders thrown back.

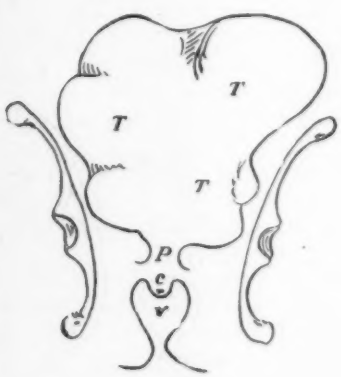


FIG. 1.

Represents a coronal section of the pelvis through the acetabula. *T. T. T.* is a large myomatous uterine tumor filling the lower part of the abdominal cavity, *c* is the cervix uteri, and *v* the vagina. This diagram differs generically from three of the cases under consideration in that the broad ligaments in this are not lifted up out of the pelvis.

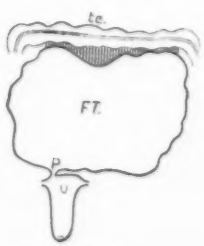


FIG. 2.

Shows the large myomatous mass *FT*, attached at *P* to the fundus of the uterus *U*, and above closely and widely adherent to the transverse colon *te*, and behind this to the small intestines.

A complete mimicry of the exaggerated posture and gait of pregnancy is rarely observed in the myomatous uterus because the main masses of such tumors are usually disposed laterally in the abdominal cavity, over the normal centre of gravity of the body, as well as anteriorly, and the change in shape is much less rapid. The deliberate gait, however, is oftenest observed.

CASE I.

Large Myoma Uteri.—Myomectomy.—Recovery.

The first tumor removed was this mass—25 × 20 × 17 cm.,—taken from a negress sent me by Dr. C. Morris Cheston, of West River, Md. An abdominal incision was made 20 cm. in length, over the most prominent part of the tumor.

The tumor was found attached to the right side of the fundus uteri by a short fleshy pedicle 3 cm. long, containing a few blood vessels, from one to one and a half millimeters in diameter (*v. Fig.* 2).

It was at once clear that the large growing mass was not dependent upon this insufficient source for its vitality.

The query was answered by discovering at the opposite pole of the tumor a fringe of large dilated sinuous omental vessels, from 2 to 3 mm. in diameter and from 3 to 5 cm. in length, parallel to one another and disposed transversely in the abdomen, occupying the whole of the omentum, appearing to spring from the lower border of the transverse colon.

A closer examination showed also that this upper abdominal blood supply was not limited to these colic vessels, but there were a number of close vascular attachments to some loops of the small intestines concealed beneath.

This large myomatous mass was therefore, although not completely detached from its birthplace, of a migratory parasitic nature, drawing very little nutriment from its natural host, the uterus, depending upon an extensive vascular supply developed from an adventitious attachment.

Parasitism of this kind is far from being unusual in pelvic inflammatory growths. I have several times removed inflamed ovaries, which I termed *parasitic* because their vessels in the hilum were withered and small, while a large nutrient vessel or vessels were discovered in some adhesion to the pelvic floor or intestines.

Operation.

There is a working formula from which I do not often depart in the enucleation of adherent pelvic tumors—that is to sever the natural pedicle last, here, however, the difficulties of manipulation above, in the process of enucleation, were so much greater than below, that I, in this case, first transfixed and tied off the uterine pedicle with silk ligatures, and then proceeded to deal with the omentum and its vessels.

Fig. 3.

Shows the method of treating such a close flat adhesion to the intestine by sacrificing a strip of the tumor mass, and checking hemorrhage and approximating the peritoneal surfaces, by a continuous or an interrupted suture *ll*. *ii* is small intestine.

Some of these larger vessels, on the upper surface, were easily tied off, as there was abundant room between the colon and the tumor, but beneath these was a layer of flat adhesions between tumor and small intestines, as well as to the colon, containing large blood vessels.

Simply to sever these adhesions and afterwards catch the divided vessels was out of the question, as the peritoneal surfaces would at once have widely separated, exposing an extensive bleeding area on the intestine. To catch and control such scattered bleeding points would have been tedious and full of danger to the integrity of the intestinal wall.

I obviated this difficulty in two ways, at first by making traction on the tumor and drawing down the peritoneum, sliding it over the intestine, thus creating a short pedicle which could be tied satisfactorily. This device failed where the flat adherent surface became broader, and I then resorted to another expedient with success, detaching the adhesions by dissecting off strips of the tumor 4 and 5 cm. in length and 1 cm. in breadth (*v. Fig.* 3).

These strips were slightly cupped out on the under surface, and 2 to 4 mm. in thickness. The free bleeding from the centre of the cut surface of the tumor on the strip at once showed that a large part of the blood stream from these adventitious vessels actually pierced the capsule of the tumor and passed in towards its centre. This observation was verified by artificially injecting some of these vessels, when the fluid was found to flow in at once from the periphery, the vessels breaking up into numerous branches appearing at the very centre of the mass. Other smaller branches could be distinctly seen ramifying under the peritoneal capsule of the tumor.

The hemorrhage from the strips of tumor thus removed and clinging to the intestinal adhesions was controlled by uniting to one another the parallel edges of the strip of the tumor thus left behind by interrupted silk sutures.

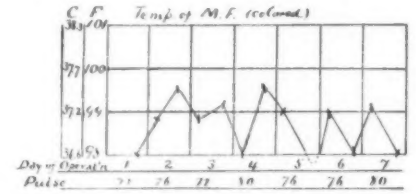
The peritoneal cavity was finally washed out with normal salt solution and the abdomen closed with drainage.

The duration of the operation was 45 minutes to the introduction of the sutures closing the abdominal wound and 60 minutes to completion.

Chloroform was given throughout.

The patient's pulse beforehand was 72, and 82 after the operation.

The subsequent history was uneventful. She had absolutely no fever, the temperature did not reach 100° F. (37.7° C.) at any time.



Case II.

Large Myoma Uteri.—Both Broad Ligaments severed down to Cervix.—Supra-vaginal Hysteromyomectomy.

The second specimen is a large multi-nodular myomatous mass, removed 9 weeks ago in Philadelphia by supra-vaginal hysteromyomectomy according to my own method.

She is a patient of Dr. G. G. Faught, of Philadelphia. She bled profusely at the menstrual periods, and in spite of rest, diet, medication and electricity under the constant supervision of Dr. Faught, the tumor continued to grow until it formed a prominent mass, thrusting the thick anterior abdominal wall out almost as far as a pregnancy at term.

The special indications for operation were, vascular disturbances, palpitation and shortness of breath and oppression, serious renal disturbance, in the form of occasional albuminuria, with markedly diminished secretion (240–750 cc. in 24 hrs.), loaded with urates and phosphates, high specific gravity and frequent micturition, the bladder not holding more than 60 cc. (2 oz.) in marked contrast to its capacity (270 cc.) within a week after operation.

One of the most cogent reasons for operating was also the extreme mental depression caused by the presence of tumor.

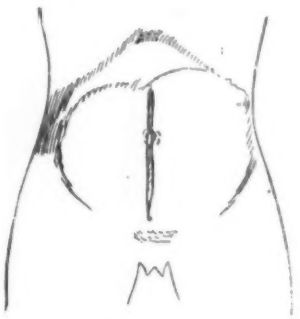


Fig. 4.

Is a generic representation of a large myoma. The long incision through the umbilicus, necessary to lift the tumor out of the abdomen, is seen in the median line.

Operation.

The operation was performed Feb. 4, 1891. Dr. C. P. Noble gave ether, and Dr. Hunter Robb stood opposite to me at the table, with Dr. Farr behind him, handing ligatures, sponges and forceps.

An incision of 20 cm. was made through fat (5 cm.) abdominal walls (*v. Fig.* 4). After lifting out the large tumor, $19 \times 25 \times 15$ cm., it was found that both broad ligaments were elevated on its sides high out of the pelvis. I clamped the side next to the tumor and applied ligatures next to the pelvic

wall, and cut through both broad ligaments obliquely, beneath the tumors to the cervix uteri. This formed the pedicle which was then constricted with a rubber ligature and the mass above cut away (*Fig.* 5), removing tumors, body of the uterus, and the upper part of the cervix (*Fig.* 6).

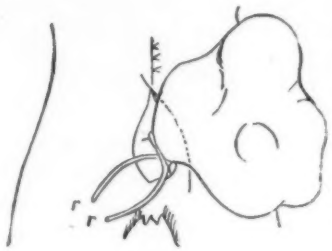


Fig. 5.

Shows the myomatous tumor lifted out of the abdominal cavity. The upper part of the incision has been closed by three sutures to keep back the bowels. *rr* is the rubber ligature encircling the pedicle, which has been formed by cutting down through both broad ligaments beneath the tumor. The dotted line is the line of incision through which the tumor is to be cut away.

The circular stump, about 4 cm. in diameter, was then carefully trimmed down to a cup shape, and the cervical canal was well burned out with the Paquelin knife. The upper raw surface of the stump was brought together in a sagittal direction by about eight interrupted stout catgut sutures (*Fig.* 7).

At this point I departed from my usual plan in using the catgut, and in not using a continuous silk suture, and further in resting satisfied with a less exact apposition of the opposed surfaces.

The next step was to pass suspensory sutures by entering a curved needle on the peritoneal surface of the stump, near its cut margin, and sweeping through its substance down to the level of the catgut sutures, where the needle was brought out, to reëenter at the bottom of the wound on the opposed lip (*Fig.* 8), through which it was carried, reappearing on the peritoneal surface at the point corresponding to the point of entrance on the other lip.

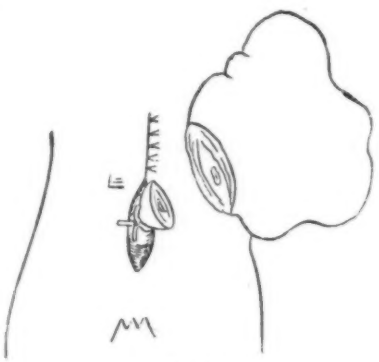


Fig. 6.

Represents the next step in advance of Fig. 5. The tumor has been severed from its pedicle, and is in the act of being removed. The rubber ligature is seen below on the pedicle encircling it like a cravat.

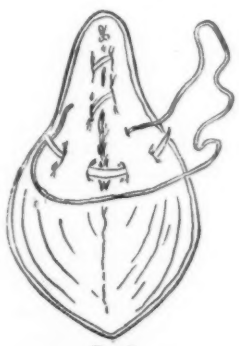


Fig. 7.

Represents the upper cupped surface of the stump in the act of being obliterated by approximating the right side to the left side, by means of a continuous catgut suture. Instead of the continuous suture, the cases in the text were closed by interrupted sutures.

Both of these steps facilitate the operation in diminishing the amount of suturing necessary.

For suspensory sutures I used silver wire, thus further protecting the stump from the late infection so certain to be introduced in a week or more by silk sutures, as well as affording the great additional advantage of being easily removed.

It is impossible, after a couple of weeks, when the wound has contracted, to expose and cut the loops of the silk ligatures at the bottom of the pit, which must therefore be left to come away of themselves after months have elapsed.

After introducing all the suspensory silver wires (about six) they were then drawn up singly and twisted from left to right five times, taking care as each wire was pulled up to secure good approximation of the opposite peritoneal surfaces.

Both uterine arteries were then tied (*Fig.* 9) on the lateral face of the stump about 2 cm. from its apex, when the elastic ligature was removed.

Shortly after the rubber ligature was relaxed, slight continuous oozing was observed between the lips of the stump, which ceased entirely upon passing two additional sutures through the stump where the blood came through, and then tying them tightly on its free margin.

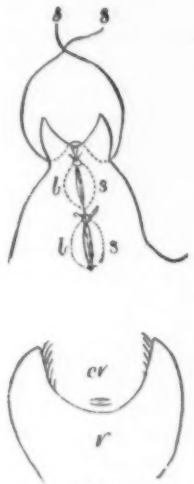


Fig. 8.

Shows the stump in the cervical portion of the uterus in coronal section. *v* is the vagina. *cv* the vaginal cervix and *ba*, *ba* are two tiers of buried interrupted catgut sutures, *ss* is a silver wire suture approximating the uppermost part of the lips and the peritoneal surfaces of the stump. This last is one of the suspensory sutures.

The abdomen was washed out and the wound closed down to the stump with a drainage tube separated from the stump area by an interval of 2 cm.

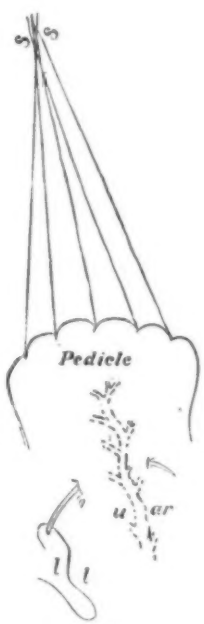


Fig. 9.

Is a sagittal section of the pedicle. The uterine artery is shown projected on the stump in dotted outline, *ss* are silver wire suspensory sutures, one of which is shown in Fig. 8. *ll* is a stout catgut ligature in the act of being carried around the uterine artery for the purpose of ligating it.

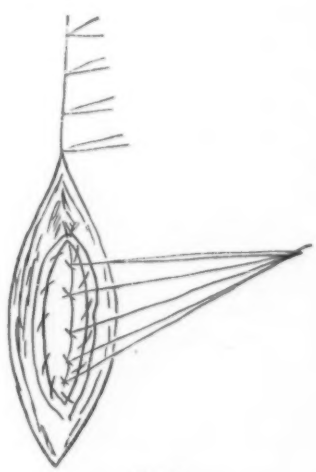


Fig. 10.

Shows the abdominal wound above, closed down to the stump. The short lines crossing the oval outline of the stump are the continuous suture uniting the parietal peritoneum to the peritoneal surface of the stump. The suspensory silver sutures, five in number, are drawn together and to the right.

The peritoneum of the stump was then united on all sides, by a continuous catgut suture, to the parietal peritoneum, just below

the silver wire sutures uniting the lips of the stump (*Fig.* 10); in this way the pedicle was swung both within and without the peritoneum, with the linear margin of the united lips projecting, not through the skin, but just beyond the peritoneum of the lower angle of the wound.

In this way the only avenue by which any hemorrhage could escape, or sepsis discharge, was really extra-peritoneal. I call the method for this reason the combined intra- and extra-peritoneal treatment of the stump.

The visible portions of the silk sutures closing the abdominal wound were saturated with a mixture of iodoform and collodion (1–15), and the line of incision sealed with the same. Over this a strip of gauze was laid, on which a mixture of celluloidin in alcohol and ether, with bichloride of mercury (1–20,000), was poured. This glued the gauze down to the skin and hermetically sealed the wound.

A loose gauze plug was put in the tube for capillary drainage.

The pit at the lower angle of the wound, in which the stump lay buried, was packed with a strip of iodoform gauze, the silver suspensory sutures being brought out in the middle. A little

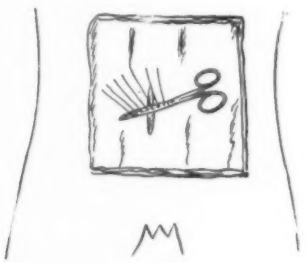


Fig. 11.

Shows the simple method of suspending the stump, to prevent its being dragged back into the abdominal cavity. The silver wire sutures are drawn through a hole in a pad of gauze covering the wound, pulled up taut and simply grasped by a pair of ordinary long-nosed artery forceps laid transversely across the wound.

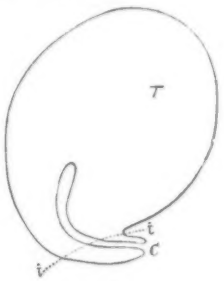


Fig. 12.

Shows the large myoma *T*, in sagittal section, encroaching on the cervical region *c*; the line of incision in forming the pedicle is shown *ii*.

pillow of gauze was laid on the skin parallel to the pit on either side and the silver sutures hauled well up, decidedly elevating the stump, and caught in the bite of a pair of ordinary long-nosed artery forceps (*Fig.* 11), laid transversely across the wound, and thus suspending the stump. Sterilized cotton was laid over the whole, and a Scultetus bandage completed the dressing.

I am indebted to Dr. R. P. Harris for the following time schedule made while I was operating.

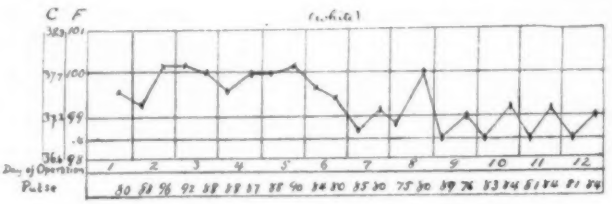
Time—1 h., 17½ min.

	h. m.
Operation commenced at	1.29
Abdomen fully opened at	1.31
Uterine tumor eventrated at	1.31½

Time occupied in tying off and cutting through the broad ligaments.

Elastic tubing applied at		1.45
Uterus amputated at		1.47½
Suturing of cervix begun	14 min.	1.55
Suturing of cervix ended		2.09
Uterine arteries ligated at		2.13
Broad ligament vessels tied at		2.20
Stump sutured to peritoneum at		2.38½
Abdominal wound closed at		2.46½

Suturing abdomen, 2.24 to 2.33.....
Sewing in stump, 2.33 to 2.38½..... } 22½ min.
Completing the closure, 2.38½ to 2.46½



The temperature record is here shown graphically.

The convalescence was free from any complications. The sutures were removed on the ninth day, when there was not a trace of suppuration from the top of the wound to the bottom. The walls of the pit where the stump lay were dry and fresh looking.

Case III.

Large Myoma Uteri.—Hysteromyomectomy.—Recovery.

Three days after performing the operation last described, I removed this large uterine tumor 13 by 18 cm. in diameter, amputating the uterus just above its cervical junction. The patient, brought me by Dr. J. C. Gilland, of Greencastle, Pa., is 46

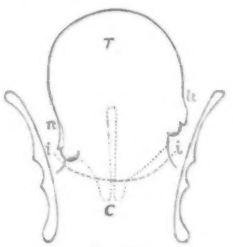


Fig. 13.

Shows the same tumor as Fig. 12, in coronal section. *T* the tumor, *rt* the right tube, *lt* the left tube. Below each tube its corresponding ovary is seen. *ii* is the line of incision through the broad ligaments below tubes and ovaries. *c* is the vaginal cervix.

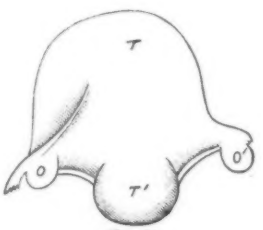


Fig. 14.

Tumor *T* occupying body of uterus, more to the right and posteriorly. *O* right ovary with long Fallopian tube above, *O'* left ovary. *T'* large spherical mass which lay behind the symphysis and pressed on bladder. The parallel lines between the ovaries and the smaller tumor shows where the broad ligaments are cut through.

years of age, single. For four years past she had suffered from a profuse menstrual flow and at intervals extensive hemorrhages, lasting for several weeks at a time, making her quite anaemic. One of these hemorrhages lasted as long as ten weeks. Urination was very frequent. She first noticed the tumor four years ago. It is therefore growing rapidly.

The operation under chloroform anæsthesia lasted 63 minutes to completion. An incision 20 cm. in length was made through the abdominal walls, and through this the large myomatous uterus was lifted out of the abdomen. The tubes and ovaries were lifted by the tumor high up out of the pelvis, and it was necessary to tie off both broad ligaments to get beneath the tumor to form a pedicle (*v. Fig.* 12).

The broad ligament veins formed large blood reservoirs. (*Fig.* 13.)

The stump of the tumor was cupped out and treated as in the last case, being finally suspended in the lower angle of the incision by my own method. A drainage tube was inserted 2 cm. above the stump.

The depth of the cavity within the portion of the uterus removed with the tumor was 3½ cm. The tumor was interstitial, lying concealed in an enormously developed muscular sheath 3 cm.

thick. The tissue within was oedematous and so soft that the finger was readily thrust into it. The drainage tube was removed in three days, all the abdominal sutures in a week, and the union found perfect throughout. The gauze which had been packed in around the stump was also removed for the first time in a week. The wound was perfectly sweet and clean. The patient recovered rapidly, without a single drawback.

Note.—The silver sutures used to suspend the stump were clearly a very great improvement upon the silk sutures, materially diminishing the discharge.

Case IV.

Large Myoma Uteri.—Hysteromyomectomy.—Recovery.

On the 25th of February I again operated for a large myomatous uterine tumor. The patient was an elderly colored woman

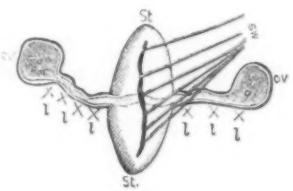


Fig. 15.

Appearance of stump after ligation of broad ligaments by ligatures *l, l, l, Ov, Ov,* the outer pelvic extremity of the broad ligaments containing the ovarian vessels. *St, st,* the stump closed by silver wires *str.*

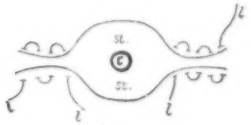


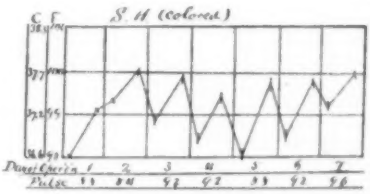
Fig. 16.

The stump from above *st, st. c* the cervical canal, *ll* continuous sutures used to draw together the exposed fleshy surfaces on top of the broad ligaments on the sides of the stump.

who was unable to work, inconvenienced by the size of the tumor, as well as by hemorrhages, and pressure on the bladder. The duration of the operation under the ether anæsthesia was 68 minutes. The operation was performed by my own method in a manner similar to the two previous operations just described. An incision 17 cm. in length was made through moderately thick abdominal walls, and the tumor exposed, lifted out and laid on layers of gauze. There was but one adhesion to the fundus of the bladder, which was 4 cm. long by 1 cm. in breadth, which was tied off. Both broad ligaments were cut through, after tying them with stout silk ligatures on the pelvic side, and clamping on the uterine side with artery forceps. A provisional rubber ligature was then thrown around the pedicle at the lower part of the uterus, and the tumor cut away, cupping out the upper surface of the stump as before.

The whole body of the uterus was thus removed, the incision passing through the cervical junction (*Fig.* 14). After burning out the cervical canal with Paquelin's cautery, the cupped surface of the stump was united, right half to left half, by six buried catgut sutures (*Fig.* 15). The same number of suspensory silver sutures were used to bring the peritoneal surfaces of the stump into apposition, fine approximation between the silver sutures being secured by catgut sutures. The stump thus closed was suspended as previously described in the lower angle of the incision, without any constriction by rubber tube or wire clamp.

A drainage tube was inserted 6 cm. above the stump and the abdominal incision closed. This patient has recovered without a single drawback, or a drop of suppuration.



These three cases just described are typical examples of the success attained by my method of treating the stump of the myomatous uterus after amputation, first described with numerous cuts in the *American Journal of Obstetrics*, April 1, 1888. My operations since that time number about 16; only one of these cases has died. This patient had extensive calcific changes in the heart muscle, and advanced nephritis; the disease was recognized, but its extent was not suspected before the autopsy.

I do not think that any other method in present use can compare with this one for safety, and above all for the exceedingly satisfactory convalescence, doing away with the delay, the danger, and the numerous annoyances of the constricted sloughing stump of the usual method.

The intra-peritoneal treatment is the ideal method, but I think it will be a long time before we will arrive at any safe plan for treating many of these big fleshy stumps in this way.

DESCRIPTION OF THE JOHNS HOPKINS HOSPITAL.

By John S. Billings, M. D., LL. D.

Containing 56 large quarto plates, phototypes and lithographs, with views, plans and detail drawings of all the buildings, and their interior arrangements—also wood-cuts of apparatus and fixtures; also 116 pages of letter-press describing the plans followed in the construction, and giving full details of heating-apparatus, ventilation, sewerage and plumbing.

CONTENTS.

Introductory: Letter of Dr. John S. Billings; Letter of Johns Hopkins to the Trustees; Preparation of Plans; Addresses at the Opening of the Hospital; Statistics of Construction.

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General Construction of Buildings: General Statements; Heating and Ventilation; Water Supply; Sewage Disposal and House Drainage; Lighting; Clocks; Telephones; The Administration Building; The Pay, Common, Octagon, and Isolating Wards; The Kitchen Building; The Nurses' Home; The Amphitheatre and Dispensary; The Pathological Building; Laundry; Bath House.

PLATES.

Front view; Block plan; Rear view; Corridor; General heating plans with sections; Pipe Tunnel, two plates; Administration Building, six plates; Pay Ward, three plates; Octagon Ward, nine plates; Isolating Ward, three plates; Kitchen Building, seven plates; Nurses' Home, eight plates; Apothecary's Building, two plates; Dispensary, two plates; Amphitheatre, two plates; Dispensary and Amphitheatre; Pathological Building, three plates; Laundry, two plates; Bath House.

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CORROSIVE SUBLIMATE AS A DISINFECTANT AGAINST THE STAPHYLOCOCCUS PYOGENES AUREUS.

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(From the Pathological Laboratory of the Johns Hopkins University.)

Some of the results of the experiments to be reported in this paper were briefly mentioned by the writer at a meeting of the Johns Hopkins Hospital Medical Society on January 6th 1890. The facts which I have determined relating to the destructive power of solutions of corrosive sublimate upon the most common of the micro-organisms of suppuration, the staphylococcus pyogenes aureus, justify a report of the investigations. The observations recently reported by Geppert,[1] regarding the destructive action of corrosive sublimate upon the spores of the anthrax bacilli, have directed attention to certain sources of error inherent in previous methods of experimentation upon the disinfectant properties of this agent. The principal source of error has been the failure to guard sufficiently against the transportation with the bacteria which have been exposed to the action of corrosive sublimate of enough of this substance to prevent the growth of the organisms in the nutrient medium intended to determine whether or not they had been killed. As a result of this error the false inference may, and repeatedly has been drawn that bacteria have been killed by the action of corrosive sublimate when their growth has simply been inhibited by the presence of a minute quantity of sublimate in the nutrient medium. Geppert claimed that anthrax spores which had been treated with corrosive sublimate and which, according to the customary modes of procedure, showed no growth upon nutrient media, might still be capable of infecting animals.

In order to remove the minute quantity of sublimate adherent to bacteria in disinfection experiments with this agent Geppert employed ammonium sulphide ($(NH_4)_2S$) to precipitate the sublimate in the form of inert sulphide. By adopting this precaution he was able to demonstrate, in opposition to generally accepted views, that the spores of anthrax bacilli are not all killed by an exposure of hours (in one case of 24 hours) to 1 : 1000 solutions of corrosive sublimate. These experiments of Geppert I have in part repeated with the same organism and have obtained in cultures results in general confirmatory of those reported by him. (I made no experiments on animals.) In the light of Geppert's publications it seems clear that much of the previous work done to determine the germicide powers of corrosive sublimate upon various species of bacteria must be repeated and in accordance with the new results, prevailing ideas as to the disinfectant power of this agent must be modified.

I have selected the staphylococcus pyogenes aureus for a series of experiments as to the germicide power of corrosive sublimate in consequence of the great practical importance of this subject to the surgeon.

The experiments hitherto made upon corrosive sublimate as a disinfectant have agreed in giving to it the first place in the list of these agents.

Koch[2] says, regarding sublimate in 1 : 1000 solutions: "By a single application for but a few minutes, without any previous preparation of the objects to be disinfected, an absolute disinfection of even the most resistant organisms is guaranteed."

Gärtner and Plagge[3] claim that if staphylococcus pyogenes aureus in bouillon cultures be mixed with corrosive sublimate in 1 : 1000 solution in the proportion of 1 c.cm. of the culture to 49 c.cm. of the sublimate solution that disinfection is completed in 8 seconds.

Sternberg,[4] whose experiments with 1 : 1000 sublimate were made for periods of exposure not less than two hours, found that most organisms were killed in this time.

Behring[5] found that the staphylococcus aureus when dried upon silk threads and then exposed to Laplace's 1 : 1000 acid sublimate was killed in 10 minutes.

Tarnier and Vignal[6] give as a result of their work 2 minutes as the time necessary to kill staphylococcus aureus in 1 : 1000 sublimate solution.

One method commonly employed in testing the value of any chemical substance as a disinfectant is to expose organisms dried upon bits of silk thread to its action for different lengths of time, and then after removing and carefully washing the threads in water and alcohol to place them into nutrient media at a favorable temperature and notice if any growth results from them. If no growth appears the disinfection was presumably successful. Another common method is to mix fluid cultures of organisms with the disinfectant and after different intervals of time a portion is taken from the mixture and placed in nutrient media just as in the other method of work.

Now in both of these methods it is easy to see that unless special precautions are taken, a minute portion of sublimate may be carried along with the thread, or drop, into the medium which is to determine whether or not the organisms on the thread or in the drop still possess the power of growth. For organisms in their normal condition, that is, those which have never been exposed to the action of a disinfectant, the amount necessary to restrain growth, for certain disinfecting agents, is very small indeed, and for those organisms which have previously been exposed for a time to such agents Geppert shows this amount to be very much less.

In the case of the organism we are considering I find the amount of sublimate necessary to prevent the growth of perfectly normal staphylococci to be one part of sublimate in 75,000 parts of the ordinary peptone bouillon, or 200,000 parts of bouillon without peptones. So that if organisms which have been once exposed to stronger solutions of this salt (1 : 1000) require less than these amounts to inhibit their growth, it is plain that special precautions must be taken to prevent the transportation of this minute trace into the nutrient medium which is to demonstrate whether or not the organisms are capable of development.

The precautions which have hitherto been taken for preventing this accident are, where the threads are employed, washing in a stream of sterilized distilled water and then in alcohol. Or,

1 Geppert, "Zur Lehre von den Antisepticis," *Berliner Klin. Woch.*, Nos. 36 and 37, 1889.

2 Koch, *Mittheilungen aus dem Kaiserlichen Gesundheitsamte*, Bd. I, 1881.

3 Gärtner and Plagge, *Verhandlungen der deutschen Gesellschaft für Chirurgie*, Vierzehnter Congress, 1885.

4 Sternberg, *Transactions of the American Public Health Association*, 1887.

5 Behring, *Cent. f. Bact. und Parasitenkunde*, Bd. III, 1888.

6 Tarnier and Vignal, *Arch. de med. experimentale et d'anatomie pathologique*, No. 4, Tome II, 1890.

where the fluid cultures were mixed with the disinfectant in solution, an effort was usually made to dilute the amount of disinfectant carried over, to a point at which it loses its inhibiting power.

As regards the silk threads, it has recently been shown by Schaefer[1] and by Braatz[2] that it is impossible to rid them of the sublimate by simple washing; as the sublimate acts as a mordant and forms a firm union with the tissues of the threads. Braatz found the same to hold for catgut. For example, he found that catgut which had been immersed in solutions of sublimate, gave the characteristic reactions of the salt after having been immersed in distilled water, which had been repeatedly renewed, for five weeks.

In his experiments upon silk threads he immersed a bit of this material and a bit of cotton thread of the same size in sublimate solutions; after a given time they were both thoroughly rinsed in distilled water and after several washings were placed in a solution of ammonium sulphide in distilled water. The silk thread gave the characteristic reaction for sublimate, whereas, there was no such reaction in the cotton thread.

Braatz remarks that a similar firm combination between sublimate and cotton will take place after a longer time, but it occurs so slowly that it can not interfere with disinfection experiments in the same way as he believes the employment of silk to act.

It seems quite probable therefore that some of the discrepancies which exist between the results of experiments to be reported in this paper and those obtained by other observers may be accounted for by their having, in many instances, employed the silk threads in their work.

From the results reported by Geppert and from those obtained by me, as will be seen in the experiments contained in this paper, the means hitherto employed have not been sufficient to remove the inhibiting amount of sublimate from the threads which have been exposed to it, and in the case of fluid cultures, the dilution has not been carried to a sufficiently great extent.

Dilution has been attempted in most cases, but as far as I can learn in rather an inexact way, so that the experimentor was not in a position to say exactly the amount of sublimate which was transferred to his nutrient media along with the organisms.

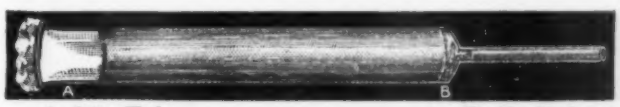
In the beginning of my experiments on staphylococcus aureus, an effort was made to employ the method described by Geppert in his work on anthrax—the precipitation of the adherent sublimate by ammonium sulphide, but as irregularities appeared in the results it was discarded and the method of exact dilution substituted.

The method employed throughout these experiments was as follows:

Fluid cultures or watery suspensions of the organisms were mixed with sublimate solutions in such proportions that the organisms were in a fluid containing sublimate dissolved in the proportion of 1 : 1000.

In order that the sublimate may have the most favorable opportunity for its action, it is desirable for the organisms to be present in the fluid suspended as single cells and not as clumps. Where clumps are present it is probable that those organisms located in the centre of the mass are protected from the action of the sublimate by those surrounding it. To rid the cultures of these clumps filtration, through glass-wool, as suggested by Geppert, was resorted to. By this means all macroscopic particles are removed from the culture, but it is possible, as may be seen microscopically, that clumps too small to be seen with the naked eye may pass through the filter and interfere in the way mentioned with the accuracy of the experiment. To exclude the presence of these smaller masses the organisms were grown in bouillon containing sand; after they had grown for the required time they were then thoroughly shaken with the sand and filtered as before through the glass-wool. The results thus obtained were of sufficient uniformity to justify our continuing the use of this method.

The filtration may be accomplished without fear of contamination of the culture by the employment of an Allihin tube which is practically nothing more than a thick-walled test tube drawn out to a finer tube at its blunt end so as to convert it into a sort of cylindrical funnel. The tube when finished and ready for use has the appearance given in the cut.



A.—Cotton Wool. B.—Glass Wool.

The whole tube, after being plugged at the bottom of its wide part with glass wool and at its wide open extremity with cotton wool, is placed vertically, small end down, into an Erlenmeyer flask of about 100 cc. capacity and sterilized in a steam sterilizer for the proper time. It is allowed to remain in the covered sterilizer until it is to be used, which should be as soon as possible after sterilization is completed.

The watery suspension or bouillon culture of the organisms is now to be filtered repeatedly through the glass wool into sterilized flasks until a degree of transparency is reached which will permit the reading of moderately fine print through a layer of the fluid of about 2 cm. thick.

The sublimate solutions were made in distilled water with chemical accuracy and from chemically pure preparations of the salt. As a rule a fresh solution was made for each experiment. At no time were solutions older than four days employed. In these cases the solution had been preserved in amber-colored bottles with well-fitting ground-glass stoppers. This precaution was to prevent the decomposition seen to occur in these solutions when exposed to light.

In order to decide upon the amount of the mixture of organisms and sublimate which might be added to our nutrient media without the sublimate having its inhibiting action, the volumes of the wire loops (oese) and dropping pipettes were determined.

The volume of the wire loop can only be taken as approximative. It was obtained by filling a burette with water to a given mark and then determining the number of times it would be necessary to dip the loop into the water in order to remove 0.1 cc. The loop of course being dried after each introduction. The determinations varied almost each time they were made but as an average of a number of such trials 2000 loopfuls to the cubic centimetre may be taken as a fair approximation.

The pipettes dropped on an average 20 drops to the cubic centimetre.

The culture tubes contained exactly 10 cubic centimetres each of the culture medium.

If, therefore, one loopful of the mixture of organisms and sublimate 1:1000 was introduced into 10 cc. of nutrient medium our 1:1000 sublimate would be diluted 20,000 times, in other words the organisms taken over on the loop (oese) are now

[1] Schaefer, *Berliner Klin. Woch.*, 1890, No. 3, p. 50.
[2] Braatz, *Cent. f. Bact. und Parasitenkunde*, Bd. VIII, No. 1, p. 8.

in a solution of 1 : 20,000,000 sublimate. As will be seen in the experiments this is not sufficient of the disinfectant to inhibit the growth of those resistant organisms which have already been exposed to the 1 : 1000 solution for so long as 10 or 15 minutes, and in some cases even longer.

After a series of experiments made in this way the plan of work was somewhat modified. With sterilized dropping pipettes a portion of the mixture of organisms and sublimate was removed from the flask containing them and one drop from the pipette mixed with 10. c. cm. of sterilized distilled water in a test tube and thoroughly shaken. With a fresh pipette a drop was taken from this tube and introduced into 10. cc. of nutrient agar, and this was then poured into a Petri dish. This tube represents what will be designated as Plate II in the list of experiments.

By this method of manipulation it is easy to see that only the merest trace of sublimate could exist in our agar plate. The pipettes dropped 20 drops to the cubic centimetre, therefore in the agar plate sublimate must have been present in amount not exceeding 1 : 40,000,000. This method gave results corresponding on the whole with those obtained where the loop (oese) was employed.

Throughout the whole of these experiments one will notice here and there certain minor irregularities—that is, occasionally one will notice a larger number of colonies on the plates made after 10 minutes exposure to the sublimate than on those after 5 minutes. I can explain this in no way other than that we are dealing with a mechanical suspension of solid particles and not with a chemical solution. In the latter case each drop contains exactly the same amount of the substance in solution as does every other drop of the same size. This is not so in the case of a suspension, and more particularly where the relative number of individual solid particles is very small. The difficulty of obtaining an even distribution of the particles through the fluid under these conditions must be plain. It is to this irregularity of distribution of the bacteria, in very small numbers, through the fluid, that I believe the discrepancies referred to are in part due.

From a perfectly homogeneous, fresh fluid culture of organisms in which the number of individuals is enormous, it is impossible to make two plates on which exactly the same number of colonies will develop, even though exactly the same amount of material may have been used throughout in both cases; how much less then are the chances for regularity in these results when the relative number of organisms in the culture capable of development is reduced through the agency of some disinfecting substance to only a very small proportion of what they originally were!

Another point that is frequently lost sight of is the difficulty, if not the impossibility, of making two or more series of experiments under identically the same conditions. Minor variations in temperature, in the proportions of the materials used, the age of the cultures employed, or the number of individual cells in the cultures, no doubt play a part not commonly recognized in influencing the result.

Henle[1] in his experiments upon creolin as a disinfectant, takes the ground that disinfection is an actual chemical process going on between the bacteria cells and the substance employed for their destruction and that this chemical activity is influenced to an appreciable degree by the temperature of the substances during the time of their contact, the disinfection being less complete at a low than at a higher temperature. These differences in temperature need not of necessity be very great in order to bring out marked variations in the result of the experiments. His ideas are borne out by experimental evidence which leads him to conclude that in order for the results of disinfection experiments to be at all comparable, they should have been obtained from experiments performed under the same conditions of temperature.

At the time of my experiments the work of Henle had not been brought to my notice, so that the temperature which was that of the room in which my experiments were performed was not observed. This may in part account for the irregularity in the results obtained by me.[2]

Another source of irregularity, and one which is exceedingly difficult to regulate, is the constancy in the actual number of individual bacteria exposed to the disinfecting agent. If, as Henle suggests, the process is a purely chemical one, then it is plain that the same amount of disinfectant will not accomplish the same end with a large number as with a small number of individual organisms. For the purpose of demonstrating this the following experiments were performed and, as may be seen from the results, the experiments made with the same amount of sublimate, but with different numbers of individual bacteria, show a relatively greater disinfecting activity where the number of individuals is small than where they are more numerous.

March 12, 1890. 1. cc. bouillon culture, 24 hours old, +49 cc. 1 : 1000. Plate I was substituted by a water tube of 10. cc. and only Plate II made of agar.

	Plate II.	
Immediately	0	Plates were counted after 72 hours at 37° C.
5 minutes	0	
10 "	0	
Immediately	0	
5 minutes	0	
10 "	0	
Immediately	0	
5 minutes	0	
10 "	0	
Control	274	

March 15, 1890. Same culture as of March 12, but containing very many more organisms as shown by control plate. Culture was kept at 37° since March 12. 1. cc. of the culture +49 cc. Sublimate 1 : 1000.

	Plate II.	
Immediately	13	Plates were counted after 48 hours at 38° C.
5 minutes	1	
Immediately	1	
5 minutes	2	
Immediately	5	
5 minutes	0	
Immediately	13	
5 minutes	2	
Control	2635	

From the above it is seen that in the first series of experiments the disinfection under the conditions employed was complete throughout, whereas in the second series, where the same culture had been allowed to multiply about ten fold, there are a certain

[1] Henle, "Ueber Creolin und seine wirksamen Bestandtheile." *Arch. f. Hyg.*, Bd. IX, Heft 2, 1889.

[2] Since the completion of these experiments there has appeared an article by Behring, upon disinfection, &c., *Zeit. f. Hyg.*, Bd. 9, Heft 3, 1890, in which not only his own experiments but those of Nocht and Hünermann confirm throughout the idea suggested by Henle as to the effect of differences in temperature upon the results of disinfection experiments. In their experiments upon staphylococcus pyogenes aureus, they show that when exposed to corrosive sublimate in 1:000 solutions at a temperature of 3° C. they are not killed in 1 hour, at a temperature of 22° C. they are not killed in 25 minutes, whereas at a temperature of 36° C. they are completely destroyed in 5 minutes.

number of organisms that have resisted similar treatment in each experiment.

The control plates were counted after 24 hours at 37° C.

Furthermore there appears to be a difference in resistance between cultures from different sources. It not unfrequently occurs that in two series of experiments made under as nearly the same conditions as possible, but with organisms of different origins a decided difference in the proportion of resistant organisms may be observed.

If, as is claimed by Eichel,[1] the pus organisms die after a relatively short time in pus obtained from abscesses in the dog, it is not improbable that organisms obtained from any old suppurative inflammation, or one in which the pus has been encapsulated for a period, will be of a lower degree of vitality and resistance than those which have not been in the presence of such deleterious products for so long a time. In chronic suppurative inflammations of a non-tuberculous type failure to detect, either by the microscope or by culture methods, the organisms which must originally have given rise to the process is not uncommon. In these cases, the organisms do not loose their biological characteristics suddenly but rather by a gradual process of degeneration of the protoplasm composing them. In the attenuation experiments upon anthrax, chicken cholera, and schweinerothlauf, the different degrees of attenuation are assumed to correspond to different degrees of degeneration and in the case of these organisms the artificially produced conditions are seen to be hereditary, so that any degree of attenuation of the pathogenic properties may be transmitted from progenitors starting from the original material at the time this degree of attenuation or degeneration is reached.

In support of the view that attenuation in virulence corresponds to degenerative changes in the organisms, the experiments of Smirnow[3] show that the different vaccines, particularly those of anthrax and schweinerothlauf, which consist of cultures of attenuated organisms are much less resistant towards the agents usually employed as disinfectants than are the normal organisms.

In his experiments upon anthrax spores Esmarch[2] has demonstrated a decided difference in resistance between spores of different ages and from different sources. His experiments, which were to determine, if such a difference in resistance exists, were made with streaming steam. His results show that in some instances the spores are killed after an exposure of one minute to the temperature of steam, whereas in other cases they resist this temperature for as long as twelve minutes. Those spores which resisted the steam for the longest period of time, likewise, exhibited the greatest resistance to 5 per cent. carbolic acid, and those which were quickly destroyed by the steam were also least resistant to the chemical disinfection.

The general observations which have been made upon the differences in resistance of organisms of the same and of different cultures, likewise the conditions which play an important part in the production of irregularities in the results of experiments are the outgrowth of my own experience and that of the observers quoted. They will, I think, serve to explain many of the irregularities in the results about to be reported.

The virulence of the staphylococcus aureus used in these experiments was demonstrated by its producing abscesses in the kidneys, myocardium and general muscular system when introduced into the circulation of rabbits.

The first group of experiments to be reported are those in which the staphylococcus aureus was employed in dilute suspensions in sterilized distilled water. In experiments made in this way, the conditions for the action of the sublimate appear to be most favorable.

The second group are those in which bouillon cultures of the same organism were employed, instead of the watery suspension, in order to determine the effect of introducing the sublimate into an albuminous medium. The results in these latter experiments differ strikingly from those in the first group and demonstrate clearly the weakening of the sublimate solution when brought in contact with bodies capable of forming insoluble compounds with it.

The suspension of organisms and solution of sublimate being prepared 10. cc. of the former were pipetted off into each of several sterilized test tubes then to one of these tubes 10. cc. of the 1 : 500 sublimate was added, thus giving a mixture in which the sublimate was present in 1 : 1000 solution along with the organisms. At the end of the different times shown in the experiments, one of the small loopfuls was removed and added to exactly 10. cc. of liquified nutrient agar and after thoroughly mixing was poured into a Petri's dish and placed in the thermostat at 37° C where it was allowed to remain for 24, 48, 72, and 96 hours, the condition of the colonies being noted.

Preliminary Experiments.

Staphylococcus pyogenes aureus suspended in sterilized distilled water and exposed to 1 : 1000 corrosive sublimate.

Series I.—Jan. 7, 1890.

Time of Exposure.	Effect of the Sublimate.
5 minutes.....	Organisms not killed.
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "

Control plate, made with same number of organisms as were taken from the sublimate to demonstrate whether or not the organisms had been killed, was evenly covered with colonies—too many to count. In the above experiment the organisms which had resisted the action of the sublimate developed on the agar plates in from 48 to 72 hours after having been placed in the thermostat.

Series II.—Jan. 11, 1890.

Time of Exposure.	Effect of the Sublimate.
5 minutes.....	Organisms not killed.
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "

Control plate evenly covered—too many to count.

Series III.—Jan. 13, 1890.

Time of Exposure.	Effect of the Sublimate.
5 minutes.....	Organisms not killed.
5 "	" " "
5 "	" " "
5 "	" " "
5 "	" " "

Control plate evenly covered—too many to count.

[1] Eichel, "Die Wachsthumsverhältnisse des staphylococcus pyogenes aureus, &c., im keimfreien Hundeeiter." *Virchow's Archiv.*, Bd. CXXI, Heft. 1.

[2] Esmarch, "Milzbrandsporen als Testobject bei Prüfung von Disinfectienten." *Zeit. f. Hyg.*, Bd. 5, 1889, p. 67.

[3] Smirnow, Ueber das Wesen der Abschwächung pathogener Bacterien. *Zeitschrift f. Hygiene*, Bd. 4, 1888.

SERIES IV.—Jan. 26, 1890.

In order to form some idea as to the number of organisms which resisted the action of the sublimate, a series of experiments was made with a very dilute suspension of the staphylococcus in water. The control plate, made as described above, in this series gave 3906 colonies after 24 hours at 37.5° C. Below are given the number of organisms resisting the sublimate after different times of exposure.

Exposure to 1 : 1000 Sublimate.

	Resistant Organisms after 5 minutes.	10 minutes.	
Experiment No. 1.....	79.....	82	
" No. 2.....	223.....	41	
" No. 3.....	384.....	15	
" No. 4.....	168.....	36	
" No. 5.....	78.....	70	
" No. 6.....	43.....	1	
" No. 7.....	23.....	10	
" No. 8.....	5.....	1	—Counted after 72 hours at 37° C.
" No. 9.....	2.....	10	
" No. 10.....	1740.....	522	

Except in experiment No. 8 of this series the colonies were counted after 48 hours at 37° C.

In this series the sublimate solution employed was four days old. A fresh solution from another source[1] was prepared and the following series was begun.

SERIES V.—Sublimate chemically pure from a different source from that used in Series IV. Control plate gave 6,426 colonies after 24 hours at 37° C.

Exposure to 1 : 1000 Sublimate.

Resistant Colonies after

	10 Minutes.			15 Minutes.			20 Minutes.		
	After 48 hours at 37° C.	After 72 hours at 37° C.	After 96 hours at 37° C.	After 48 hours at 37° C.	After 72 hours at 37° C.	After 96 hours at 37° C.	After 48 hours at 37° C.	After 72 hours at 37° C.	After 96 hours at 37° C.
No.1.	0	1	1	0	0	0	0	0	0
No.2.	0	0	0	0	0	0	0	1	1
No.3.	7	7	8	0	0	1	3	4	5
No.4.	2	3	3	0	0	0	0	0	0
No.5.	0	0	0	0	1	1	0	2	3
No.6.	—	—	—	0	0	0	1	1	1
No.7.	—	—	—	0	1	2	0	1	1
No.8.	—	—	—	0	1	1	1	1	1
No.9.	—	—	—	0	0	0	0	1	1

To determine the diminution in its disinfecting value, brought about by allowing the sublimate to act upon organisms suspended in an albuminous medium, a very dilute suspension of staphylococcus aureus was prepared with the ordinary nutrient bouillon employed in bacteriological work.

These experiments were made in exactly the same way as those in which the organisms were suspended in water.

SERIES VI.—Organisms in bouillon.

Control plate gave 8875 colonies after 24 hours at 37.5° C.

Time of Exposure.	Number of Resistant Organisms as shown by Colonies.	
20 minutes.....	1575	Counted after 24 hours at 37.5° C.
20 "	1320	
20 "	1206	
20 "	1284	
20 "	1496	
30 minutes.....	915	After 24 hours at 37.5° C.
30 "	1012	
30 "	261	
30 "	603	
30 "	1365	
40 minutes.....	896	After 24 hours at 37.5° C.
40 "	1044	
40 "	341	
40 "	55	
40 "	460	
60 minutes.....	70	After 48 hours at 37.5° C.
60 "	46	
60 "	62	
60 "	7	
60 "	13	

Aside from the differences seen between the two groups of experiments—the one in which the organisms were suspended in water, the other in which they were suspended in an albuminous medium—there are other rather interesting conditions, namely the retardation in the time of appearance of the colonies of bacteria which have not been killed by the sublimate. A glance at the experiments will show that in most cases where the exposure to the sublimate has been a short one, 5 minutes, the colonies from the resistant organisms could be recognized without difficulty after 48 hours at 37.5° C., whereas, when the exposure reached 10, 15 and 20 minutes, here and there single fresh colonies would appear as late even as 96 hours. In the bouillon experiments with exposure of 20, 30 and 40 minutes the resistant organisms could easily be recognized after 24 hours at 37.5° C., whereas, when the exposure was extended to 60 minutes, 48 hours at this temperature became necessary. From this it seems probable that while a certain proportion of the individuals in a culture exposed to sublimate may be killed at the beginning, certain others succumb to its action only gradually, and if removed from its influence before actually killed still possess the power of reproduction, though apparently in a very much enfeebled way.

Repetition of Gärtner and Plagge's Experiments.

February 15th.—1 cc. fresh bouillon culture from a boil + 49 cc. fresh sublimate 1 : 1000. One drop added to 10 cc. agar and one drop of this to a second 10 cc. agar, both plated. (Drop $\frac{1}{20}$ cc.) On the control plate in which water was substituted for $HgCl_2$ the number of colonies was countless after 24 hours. Plates made as follows:

	Plate I.	Plate II.	
Immediately.....	0.....	0	Plate I contained sublimate 1 : 200,000
5 Minutes.....	0.....	0	Plate II " " 1 : 40,000,000
10 "	0.....	0	
15 "	0.....	0	
20 "	0.....	0	

February 15.—20 cc. of same bouillon culture + 20 cc. 1 : 500 sublimate.

	Plate I.	Plate II.	Oese.[2]	
5 minutes.....	2.....	1616.....	1938	Counted after 48 hours at 38° C.
15 "	0.....	0.....	2	
30 "	0.....	13.....	91	

Control countless.

February 18.—1. cc. fresh bouillon culture + 49 cc. 1 : 1000.

	Plate I.	Plate II.	Oese.	
Immediately.....	0.....	0.....	75	—after 24 hours.
5 minutes.....	0.....	0.....	19	—after 48 hours.
Control.....	Countless.....	590.....	5360	

The above condition not changed after 72 hours at 37° C.

February 18.—Same bouillon culture and same sublimate as employed in the other series of to-day.

20 cc. culture + 20 cc. sublimate 1 : 500.

	Plate I.	Plate II.	Oese.
Immediately...	170.....	4968.....	25340
5 minutes.....	74.....	466.....	8844
Control.....	∞.....	19520.....	∞

February 19.—Two series—made with same weight of sublimate, in the one case the sublimate was present in solution of 1 : 1000, in the other in 1 : 20,000.

[1] In examining the samples of commercial sublimate from different manufacturers I found that certain of them contained an appreciably large proportion of insoluble impurity. It became necessary therefore to recrystallize some of these samples. Others were found to be of chemical purity, so that they could be used as they came from the shops.

[2] In this column are the results of experiments in which one small oese was taken from the original mixture and added to 10 cc. liquified nutrient agar which was then plated.

Series I.—10 cc. of 1:1000 (0.01 gram. $HgCl_2$) + 4 drops bouillon culture of staphylococcus aureus.

	Plate I.	Plate II.	Oese.
Immediately...	0.....	0.....	0—3 appeared after 72 hours.
5 minutes.....	0.....	0.....	0
10 "	0.....	0.....	0
Control.....	∞.....	7623.....	16590

Series II.—200 cc. of 1:20,000 (0.01 $HgCl_2$) + 4 drops of same bouillon culture.

Immediately...	0.....	335—after 72 hours.
5 minutes.....	0.....	152— " 48 "
10 "	0.....	0— " 48 "
Control.....	∞.....	3213— " 24 "

February 24.—Comparative experiments—between 1:1000 and 1:10,000—using the solutions so as to have the same weight of sublimate and nearly the same number of organisms present.

Series I.—10 cc. of 1:1000 (0.01 gram. $HgCl_2$) + 4 drops of suspension of staphylococcus aureus.

	Plate I.	Plate II.	Oese.
Immediately...	2816.....	832.....	5890
5 minutes.....	153.....	28.....	616
Control.....	∞.....	1824.....	Accident.

Series II.—100. cc. of 1:10,000 + 4 drops of suspension of staphylococcus aureus.

Immediately...	9.....	2795.....	618
5 minutes.....	0.....	2646.....	420
Control.....	∞.....	∞.....	2541

Counts in both cases made after 48 hours.

February 26.—1. cc. bouillon culture staphylococcus aureus + 49 cc. 1:1000.

	Plate I.	Plate II.	
Immediately...	4.....	0	(Temp. of agar 50° C. when first plates were made.)
5 minutes.....	92.....	83	48 hours at 38° C.
10 "	173.....	79	
Control.....	∞.....	3780—24 hours.	

½ cc. of same culture + 49 cc. 1:1000.

Immediately...	429.....	924	48 hours at 38° C.
5 minutes.....	31.....	720	
10 "	0.....	38	
Control.....	∞.....	2394—24 hours at 38° C.	

February 27.—Comparative experiments with same weight of sublimate diluted to different degrees and acting upon nearly the same number of organisms.

1. cc. staphylococcus aureus in water + 49. cc. 1:100.

	Plate I.	Plate II.	
Immediately...	0.....	0	48 hours at 38° C.
5 minutes.....	0	0	
Control.....	∞.....	1386—24 hours at 38° C.	

1. cc. staphylococcus aureus in water + 400 cc. of 1:20,000.

Immediately...	21.....	51
5 minutes.....	0.....	13
10 "	0.....	6
Control.....	∞.....	∞

Inhibiting point. Peptone Bouillon, containing sublimate in the following proportions.[1]

The columns 24 hours, 48 hours, 72 hours, 96 hours, indicate the length of time it was necessary for the bouillon containing the different proportions of sublimate to stand at the temperature of 37° C. before growth appeared.

	24 hours.	48 hours.	72 hours.	96 hours.
1:600,000.....	+	+	+	+
1:400,000.....	—	+	+	+
1:200,000.....	—	—	+	+
1:175,000.....	—	+	+	+
1:150,000.....	—	+	+	+
1:125,000.....	—	+	+	+
1:100,000.....	—	+	+	+
1: 87,500.....	—	+	+	+
1: 75,000	—	—	—	—

[1] In these experiments, the sign + indicates growth, the sign — indicates no growth.

Bouillon without peptone. Sublimate present in the following proportions.

	24 hours.	48 hours.	72 hours.	96 hours.
1:800,000.....	+	+	+	+
1:600,000.....	—	+	+	+
1:300,000.....	—	—	+	+
1:200,000.....	—	—	—	—

February 28.—Bouillon culture of staphylococcus aureus filtered. 1 cc. + 49 cc. 1:1000.

	Plate I.	Plate II.
Immediately...	0.....	0
5 minutes.....	0.....	0
10 "	0.....	4
Control.....	Water.....	3834

½ cc. same culture + 49 cc. 1:1000.

	Plate I.	Plate II.
Immediately...	0.....	0
5 minutes.....	0.....	0
10 "	0.....	1
Control.....	∞.....	1496

February 28.—1 cc. staphylococcus aureus in water + 49 cc. 1:1000.

	Plate I.	Plate II.
Immediately...	0.....	1
5 minutes.....	0.....	0
10 "	0.....	0
Control.....	Water.....	2318

Above plates observed at 48, 72 and 96 hours at 38° C.

March 5.—1. cc. suspension of staphylococcus aureus in ascitic fluid + 49 cc. 1:1000.

	Plate I.	Plate II.
Immediately...	422.....	17
5 minutes.....	4.....	11
10 "	13.....	4
Control.....	∞.....	(Accident.)

1 cc. of same suspension + 99 cc. 1:1000.

	Plate I.	Plate II.
Immediately...	472.....	8
5 minutes.....	72.....	9
10 "	14.....	0
Control.....	∞.....	45—After 24 hours.

March 17.—To determine if very old cultures, on artificial culture media, are more resistant than fresh ones (or vice versa). 1 cc. of culture employed March 15 (6 days old) was diluted 10 times with sterilized bouillon. 1. cc. of this dilution was mixed with 49. cc. 1:1000.

	Plate II.	
Immediately.....	1	Counted after 72 hours at 37° C.
5 minutes.....	2	
Immediately.....	4	
5 minutes.....	9	
Immediately.....	59	
5 minutes.....	9	
Control.....	198—24 hours.	

March 21.—Bouillon culture of staphylococcus aureus, 24 hours old. 1. cc. added to 49. cc. 1:1000.

	Plate II.	
Immediately.....	0	72 hours.
5 minutes.....	0	
Immediately.....	4	
5 minutes.....	0	
Immediately.....	2	
5 minutes.....	0	
Immediately.....	2	
5 minutes.....	0	
Control.....	527—24 hours.	

April 1. Old culture of staphylococcus aureus on potato—dated February 14. Suspended in bouillon, filtered and used immediately. 1 cc. + 49 cc. 1:1000. To see if more resistant forms are present in old cultures.

Plate II.

Immediately	14	After 48 hours at 38° C.
5 minutes	112	
Immediately	0	
5 minutes	0	
Immediately	158	
5 minutes	0	
Immediately	10	
5 minutes	0	
Control	185	After 48 hours.
Control	155	

From the results of these experiments it is plain that between cultures of 24 hours, 6 days and 6 weeks old on artificial media, there is no considerable difference in the powers of resistance.

The irregularities noticed in the experiments upon staphylococcus aureus in 1:1000 up to April 1 are evidently due to differences in the resistance of individuals in the cultures. To select the most resistant organisms the following plan was adopted:

It was noticed when certain members of a culture resisted the action of the bichloride that frequently the colonies growing from these individuals were somewhat altered in their characteristics. They were of a tenacious consistency and of an intensely orange color. If an attempt to take up a portion of one of them on a needle was made, it resulted in either drawing out into fine silky filaments or the whole colony would come away *en masse*.

Microscopically, these colonies were composed of cocci not distinguishable morphologically from staphylococcus aureus. Here and there groups of spherical cells could be seen imbedded and massed together in a hyaline substance. If a culture from one of such colonies was started in bouillon the growth after 24 to 48 hours appeared, not as the homogeneous clouding common for the staphylococcus aureus, but as numerous clumps or as a stringy, tenacious mass which settled on the sides and bottom of the tube. It is with great difficulty that a homogeneous suspension from one of such colonies can be made in bouillon or water. This is not the case with staphylococcus aureus which has not been in the presence of sublimate.

That these colonies are simply modifications of the staphylococcus aureus is seen by their growth upon the different media and their pathogenic action in rabbits.

If one injects into the circulation of a rabbit 0.5 cc. of a bouillon culture from one of these colonies, the pathological changes, though slightly retarded and a little less extensive than with normal organisms, are still characterized by abscesses in the general muscles, heart muscle and kidneys.

On gelatine they cause liquefaction; in milk they bring about coagulation with acid reaction, and on potato they grow with a distinct orange color.

If then, from any fresh culture of staphylococcus aureus which is exposed to sublimate, certain individuals resist its action it seems reasonable to suppose that those which resist it for the longest time are the more resistant members of the culture. On this line, then, cultures of staphylococcus aureus were started from rabbits which had died as results of inoculation of this organism into their circulation, and these bouillon cultures were then exposed to the action of 1:1000 sublimate for 5, 10, 15, 20, 30, 40, 60 minutes, in the proportion of 1. cc. of culture to 49. cc. of the sublimate solution.

Frequently all the organisms would be destroyed after 5 minutes' exposure, but almost as often a certain few would resist for that length of time and even longer, going in some cases to 10, 20, and even 30 minutes.

From these resisting colonies fresh cultures would be started and different generations from these colonies exposed in turn to the action of the 1:1000 sublimate solution. From the experiments it is seen that the earlier generations, first, second, third, etc., from one of the resisting colonies, were frequently quite unable to resist a second application of the sublimate, but as further cultures were made, the power of resistance became gradually increased until, when the sixth and seventh generations were reached, we now had a culture in which there were forms not only capable of resisting the action of the sublimate up to 10 and 20 minutes, but resisted it in fairly large proportion.

Exceptionally a high degree of resistance could be observed in the very early generations. (See experiments of May 26th.)

The same may be said of the pathogenic value of these resisting colonies. The first generations, that is up to the seventh and eighth from resisting colonies, are frequently incapable, when injected into the circulation of rabbits in the ordinary amounts of from 0.3–0.5 cc. of a bouillon culture, of giving rise to the characteristic abscess formation in the kidney and muscles which are seen to follow the injection of the same amount of a culture which has not previously been exposed to sublimate. After the ninth generation the organisms appear to gradually regain their virulence until they are finally capable of producing those changes which follow constantly the injection into the circulation of normal organisms.

As an illustration.

May 12.—Bouillon culture of staphylococcus aureus which is the second generation from rabbit, dead of multiple abscesses, was exposed to 1:1000 sublimate in the proportion of 1. cc. of culture to 49 cc. of bouillon for different lengths of time.

Plate II.

Immediately	663	All appeared after 24 hours at 38° C.
5 minutes	825	
10 "	660	
Control	1296	

Plate I was water.

Duplicate of above made at same time gave

Immediately	1180	All appeared after 24 hours at 38° C.
5 minutes	1080	
10 "	660	
Control	1624	

From the resisting colonies on the 10 minute plates, cultures in bouillon were started and allowed to grow for 10 days. At the end of this time there was a tenacious mass at the bottom of the tubes. The tubes were well shaken and one of the cultures filtered through glass wool and the other shaken with sand and filtered through glass wool. Experiments of May 26 were then made. One culture neither shaken with sand nor filtered.

May 26.—1. cc. from these bouillon cultures + 49 cc. 1:1000 sublimate.

(*a*) Not filtered and not shaken with sand.

Plate II.

Immediately	1980	All appeared after 24 hours at 38° C.
5 minutes	392	
10 "	392	

Here we have, assuming control to be equal to that of the following two experiments—10 per cent. resistant colonies. In this experiment there was an accident with the control.

(*b*) Filtered but not shaken with sand.

Plate II.

Immediately	2340	All appeared after 24 hours at 38° C.
5 minutes	720	
10 "	900	
Control	3720	

(*c*) Filtered and also shaken with sand.

Immediately	1200
5 minutes	1800
10 "	164
Control	3900

All appeared after 24 hours at 38° C.

From the ten minute plates in these experiments, cultures in agar were again started and allowed to grow until May 29, when experiments of that date were made.

May 29.—These experiments were made with 1. cc. of a watery suspension of staphylococcus aureus + 49. cc. of 1 : 1000 sublimate. The suspension was filtered through glass wool before using.

	Plate II.			
Immediately	147	After 24 hours at 38° C.	= 166	After 48 hours at 38° C.
5 minutes	1		= 3	
10 "	1		= 2	
15 "	0		= 0	
Control	258—after 24 hours.			

June 4.—A bouillon culture, 24 hours old from the 10 minute plate of May 29, was employed. This culture was filtered through glass wool and diluted with an equal volume of sterilized bouillon in order to see if a diminution in numbers affected the results of the exposure. 1. cc. + 49. cc. of 1 : 1000.

	Plate II.			
(1) Immediately	81	all appeared after 24 hours at 38° C.	= 86	after 48 hours at 38° C.
(2) 5 minutes	122		= 132	
(3) 10 "	14		= 22	
(4) 15 "	13		= 19	
(5) 20 "	5		= 7	
(6) 30 "	0		= 3	
(7) 45 "	0		= 0	
(8) 60 "	0		= 0	
(9) Control	114		= 207	

In this experiment 14 per cent. resisted for 10 minutes.

June 18.—From plate No. 6, of June 4, a series of generations were started, and on June 18, the fourth generation which was 24 hours old in bouillon over sand, was employed in the proportion of 1. cc. of culture + 49. cc. of sublimate. This experiment was in two parts.

(*a*) Shaken with sand but not filtered.

	Plate II.	Plate II.	
5 minutes	12	41	All after 48 hours at 38° C.
10 "	2	0	
20 "	0	0	
Control	974	792	

(*b*) Shaken with sand and filtered through glass wool.

	Plate II.	Plate II.	
5 minutes	67	20	
10 "	4	1	
20 "	0	1	
Control	420	640	

June 20.—Third generation from plate 6, of June 4—shaken and filtered. In this experiment the organisms were removed from the sublimate at the end of 5, 10, 20, and 30 minutes, and placed in 10. cc. of distilled water to which 2 drops of $(NH_4)_2S$ had been added. From this Plate II was made

	Plate II.	Plate II.	
5 minutes	0	0	After 72 hours.
10 "	0	0	
20 "	0	0	
30 "	0	0	
Control	—	80	

The colonies on the control plates were *not* tenacious, but were creamy, as is normally the case with these organisms when not having been exposed to sublimate.

June 23.—A bouillon culture over sand. 3 days old from the 10-minute plates of June 18. Well shaken with sand but not filtered. 1. cc. of culture, + 49 cc. of 1 : 1000 sublimate.

	Plate II.	Plate II.	
(1) 5 minutes	386	369	48 hours at 38° C.
(2) 10 "	48	312	
(3) 15 "	20	42	
(4) 20 "	8	27	
(c) Control	1500	1620—24 hours at 38° C.	

Colonies tenacious.

Bouillon cultures over sand made from the 20-minute plates.

June 26.—First generation in bouillon over sand from plate 4 of June 23. 24 hours old. Well shaken with sand.

(*a*) Not filtered.

	Plate II.	Plate II.	
5 minutes	0	0	48 hours at 38° C.
10 "	0	0	
15 "	0	0	
20 "	0	0	
Control	683	826—24 hours at 38° C.	

(*b*) Shaken with sand and filtered through glass wool.

5 minutes	0	0	48 hours at 38° C.
10 "	0	0	
15 "	0	0	
20 "	0	0	
Control	452	104 (?)	

Colonies on control plates adherent.

On June 27, ½ cc. of this same bouillon culture was injected into circulation of a rabbit. No result. (See notes on this animal.)

Since the culture employed in this experiment was only the first generation from the experiments of June 23, and was but 24 hours old, the results here obtained may be due to the short interval of time between the exposures. Perhaps some lessened resistance may exist which disappears in the fourth or fifth generation and the organisms again became able to withstand the action of the sublimate. See following series of experiments designated as A, B, C, D, E, F, G and H:

July 7, Experiment A.—Second generation over sand in bouillon from plate 4 of June 23. This culture was 12 days old. Filtered and shaken with sand. 1. cc. + 49 cc. sublimate.

	Plate II.	Plate II.	
5 minutes	0	0	72 hours at 38° C.
10 "	0	0	
15 "	0	0	
20 "	0	0	
Control	303	269	

Colonies on control plates tenacious.

July 9, Experiment B.—Fifth generation in bouillon over sand from plate 4 of June 23. Shaken with sand and filtered. 1. cc. + 49 cc. 1 : 1000.

	Plate II.	Plate II.	
5 minutes	0	0	72 hours at 38° C.
10 "	0	0	
15 "	0	0	
20 "	0	0	
Control	596	582	

July 11, Experiment C.—Sixth generation from plate 4 of June 23. In bouillon over sand. Shaken and filtered. 1. cc. + 49 cc. 1 : 1000.

	Plate II.	Plate II.	
(1) 5 minutes	3	4	72 hours at 38° C.
(2) 10 "	2	4	
(3) 15 "	0	1	
20 "	1	2	
(4) Control	560	594	

July 16, Experiment D.—Seventh generation from plate 4, of June 23. Culture was 4 days old in bouillon. Not over sand. Well shaken and filtered through glass wool. 1. cc. + 49 cc. 1 : 1000.

	Plate II.	Plate II.
5 minutes	25	89
10 "	4	51
15 "	7	4
20 "	4	6
Control	1160	1180

July 18, Experiment E.—Ninth generation from plate 4, of June 23 This culture was in bouillon over sand. Was 24 hours old and was well shaken and filtered through glass wool before being exposed to the sublimate. 1. cc. of culture + 49. cc. 1:1000.

	Plate II.	Plate II.	
5 minutes.....	30.....	12	After 48 hours at 38° C.
10 "	2.....	0	
15 "	0.....	0	
20 "	0.....	1	
Control.....	650.....	536	—After 24 hours at 38° C.

July 21, Experiment F.—Eleventh generation from plate 4, of June 23. Same material as was injected with rabbit of this date. Shaken with sand and filtered through glass wool. 1. cc. culture + 49. cc. 1:1000.

	Plate II.	Plate II.	
5 minutes.....	63.....	266	After 48 hours at 38° C.
10 "	2.....	15	
15 "	0.....	2	
20 "	0.....	1	
Control.....	1246	1440	—After 24 hours at 38°C.

In this experiment the 5 minute plates showed small pin-point colonies after 24 hours at 38° C., but they were not counted until after 48 hours at that temperature.

July 24, Experiment G.—Thirteenth generation from plate 4 of June 23. Culture 24 hours old in bouillon over sand. Was well shaken and filtered. 1. cc. culture + 49 cc. 1:1000.

	Plate II.	Plate II.	
5 minutes.....	289.....	290	After 48 hours at 38° C.
10 "	4.....	14	
15 "	1.....	0	
20 "	1.....	1	
Control.....	738.....	706	—After 24 hours at 38° C.

All the resisting colonies were very tenacious.

July 28, Experiment H.—Fifteenth generation from plate 4 of June 23. In bouillon over sand. Well shaken and filtered. 1. cc. + 49 cc. 1:1000. Culture was 48 hours old.

	Plate II.	Plate II.	
5 minutes.....	48.....	26	After 48 hours at 38° C.
10 "	42.....	43	
15 "	4.....	0	
20 "	1.....	1	
Control.....	1260.....	1500	—After 24 hours at 38° C.

July 26.—An effort was made to demonstrate the difference in behavior toward nutrient media containing minute amounts of sublimate, between organisms which had already been exposed to the action of 1:1000 sublimate solutions and those not so exposed.

For the purpose a mixture of 1. cc. of a bouillon culture of staphylococcus aureus, the same culture as was employed in the experiments of July 24, and 49. cc. of a 1:1000 sublimate solution two days old was made. After allowing the organisms to be exposed to the sublimate for 5 minutes, the plates were made as follows:

Series A. One drop from the mixture was added to 10. cc. of sterilized distilled water in a test tube and was well shaken. From this a drop was taken and added to 10. cc. of normal nutrient agar which was then poured into a Petri dish—this dish is designated as Plate II. After 24 hours, as is not commonly the custom, the plates showed the presence of a large number of colonies, they were counted as follows:

Duplicates.

	Part II.	Part II.
5 minutes.....	563.....	1152
Control.....	1054.....	1364

It will be born in mind that in the control plates the original mixture was 1. cc. of bouillon culture + 49. cc. of sterilized distilled water instead of 1:1000 sublimate.

Series B. In this series a drop from the mixture of 1. cc. of bouillon culture and 49. cc. of 1:1000 was added directly to each of two tubes of 10. cc. of liquified, nutrient, normal agar, and poured with Petri dishes—these dishes which are duplicates the one of the other, are designated as plate I.

	Plate I.	Plate I.	
5 minutes.....	0.....	0	—After 72 hours at 38° C.

The control of Series A was taken as the control from Series B.

In Series B, the organism which had already been exposed to 1:1000 for 5 minutes were transferred to the agar in a drop, so that the agar in which they now found themselves contained sublimate in the proportion of 1:200,000.

Series C. In this series a mixture of 1. cc. of the same culture and 49. cc. of sterilized distilled water was made. And from this one drop was added to each of two tubes of 10. cc. of liquified nutrient agar containing sublimate in the proportion of 1:200,000. They were then poured into Petri dishes. These dishes are designated as Plate I. They are duplicates the one of the other.

Plate I.	Plate I.	
26.....	5	—after 48 hours at 38° C.

By comparing Series B and C, we see that some of the organs which have not been exposed to 1:1000 sublimate solution when added to nutrient media containing sublimate in the proportion of 1:200,000 are capable of development, whereas no such evidence of life is seen when organisms which have been so exposed are placed under similar conditions.

There can be but little doubt that the irregularities observed in many of these experiments are due in part to differences in the resistance of certain individuals in the cultures. It has been pointed out that the character of the colonies from those individuals which did not succumb to the influence of the sublimate was frequently different from that of the organisms which had not been so treated. These colonies in many instances were composed of cocci, apparently bound together by some mucilaginous material that rendered them quite tenacious, so that in efforts to take up portions of one of such colonies upon the point of the platinum needle, either the whole colony came away from the gelatine or it drew out into long silky filaments.

Microscopically, these colonies were made up of cocci, not distinguishable from staphylococcus aureus in their morphology, but they appeared to be imbedded in a hyaline mucoid material which did not take up the staining reagents, but whose presence could readily be detected.

That these colonies are simply modifications of the staphylococcus aureus is seen by their general reactions toward the different culture media and their pathogenic behavior in the tissues of rabbits. On gelatine they cause liquefaction, in milk they bring about coagulation with acid reaction, on potato they grow with a distinct orange color, and when injected into the circulation of rabbits the pathological changes which result, though slightly retarded and a little less extensive than those following the injection of normal organisms, are still characteristic, namely, abscesses in kidneys, myocardium and general muscular system.

This observation, pointed to the possibility of attenuating the virulence of these organisms by means of successive exposures to to sublimate, and though the work done by me in this direction with the staphylococcus aureus is by no means complete, still I shall report in this place the conclusions which have been drawn from what I have thus far done and reserve the completion of this part of the experiments for another publication. The inferences to be drawn from these experiments are:

(*a*) That by injecting into the circulation of rabbits, suspensions of colonies which appear upon the plates made from the organisms which have been in sublimate for twenty minutes, the intensity

of the resulting pathological changes is often seen to be very much diminished.

September 14, Experiment.—One cubic centimeter of a bouillon culture of staphylococcus aureus, which was the sixth generation from a kidney-abscess of a rabbit, dead from injection into its circulation of staphylococcus aureus which had never been exposed to the action of sublimate, was mixed with 49 cc. of 1 : 1000 sublimate. At the end of ten, fifteen, and twenty minutes plates were made from the mixture of aureus and sublimate in the way already described. After 48 hours three colonies appeared on the twenty-minute plates. These were broken up in 2. cc. of sterilized distilled water and 0.5 cc. of this suspension was injected into the circulation of a rabbit. During the second and third days after inoculation the rabbit showed the usual effects. There was, as is usual in these cases, excessive diuresis. This gradually passed away and the animal was apparently well.

On September 29 the animal was found dead in its cage. The autopsy revealed the presence of a gray cheesy patch on the left abdominal wall. This patch was of about 2 x 3 mm. in area and was evidently the remains of an abscess formation. Along the right and left ventral aspect of the spinal column were a number of lancet-shaped, cheesy deposits, lying with their long axes in the long axes of the muscles. These cheesy collections were located between the muscle fibres and upon microscopic examination showed themselves to be the remains of small abscesses.

The left kidney was free from change. In the right kidney was an area of about 4. mm. square of a pale grayish-yellow color. Microscopically, there were found in this area a number of small spherical bodies, pretty regular in size and shape and staining in the same way as do cocci. From their general morphology one could not say they were not cocci. Other than this the animal presented no alterations from the normal.

The plates made from the pale area in the kidney, showed after 24 hours at 38° C., the presence of five or six small colonies which were made up of cocci. They have every appearance of staphylococcus aureus, though they grow very feebly and give the impression of very much reduced vitality.

(*b*) That if instead of inoculating animals directly from the test plates, cultures in bouillon are started from these plates and animals inoculated from these bouillon cultures after they have grown for 48 hours, the course of the resulting pyaemia is as a rule not materially altered from that following the injection of normal organisms.

September 1 and August 29, Experiments.—Into the ear-vein of three rabbits were injected 0.15–0.2 cc. of bouillon culture of staphylococcus aureus. These cultures were the first generation from three colonies which appeared on the test plate made after 20 minutes from a mixture of staphylococcus aureus and 1 : 1000 sublimate. All three rabbits died in from 3½ to 5 days. The pathological changes which were found at the autopsy were characteristic. Abscesses in muscles and kidneys. Bacteriological examination of these abscesses gave staphylococcus aureus in large numbers.

(*c*) That by subjecting normal staphylococcus aureus to 1 : 1000 sublimate for varying lengths of time, selecting from this test plate those colonies which resist and subjecting cultures from these in turn to sublimate and repeating this procedure through a number of such experiments, the action of the resulting staphylococcus aureus in the tissues of animals may be very much modified.

May 29, Experiments.—A watery suspension of normal staphylococcus aureus was subjected to the action of 1 : 1000 sublimate in the proportion of 1. cc. of suspension to 49 cc. of the sublimate. Test plates made at ten minutes showed three resisting colonies.

July 4.—A bouillon culture 24 hours old from the three resisting colonies of May 29, was in the same way subjected to the action of sublimate. Three colonies appeared on the plate made at 30 minutes.

June 18.—The fourth bouillon generation from the colonies on the plate of 30 minutes of June 4, was subjected in turn to sublimate in the same way. Two colonies appeared on the plate made after 10 minutes exposure.

June 23.—First bouillon culture from the resistant colonies on the 10 minute plates of June 18, was likewise in turn subjected to the action of sublimate. After an exposure of 20 minutes, thirty-five colonies were present on the plates kept at 38° C. for 48 hours.

June 27.—Injected into the circulation of a small white rabbit 0.5 cc. of first generation in bouillon from the colonies on the twenty-minute plate of June 23.

July 7.—Rabbit well. Injected 0.5 cc. of second generation in bouillon from same source. Culture 12 days old.

July 12.—Animal dead. Autopsy—no abscesses in muscles, none in myocardium, no pericarditis, a few small yellow points in kidneys from which staphylococcus aureus was obtained in cultures.

(*d*) That this apparent attenuation of the staphylococcus aureus, so treated, is only temporary and may be caused to disappear by cultivating the attenuated organisms through successive generations in normal artificial culture media.

Experiments.—The material employed in the rabbit of June 27 (see above), which was the first generation from the 20-minute plates of June 23, was carried through successive generations in bouillon at a temperature of 38° C. As we saw in the experiment of June 27, 10 days elapsed between the first injection into the animal with the first generation from the resisting colonies. During this time the animal showed no evidence of sickness. After a second inoculation with the second generation of the same material the animal lived five days, and at autopsy showed only very slight changes.

July 21, 24.—Animals were injected with 0.25–0.5 cc. of bouillon cultures, which were the ninth and eleventh generations respectively, from the same source as that employed in rabbit of June 27. In these cases both animals died—the one after a period of eight days, the other after a period of three days.

In both autopsies the kidneys presented small abscesses.

In the animal of the ninth generation no abscesses were to be seen in the muscles. In that from the eleventh generation the muscles along the right and left ventral aspect of spinal column presented elongated lancet-shaped abscesses.

In both cases staphylococcus aureus was obtained by plates made from the abscess points.

In both cases the changes approached the appearances seen after inoculation with the normal organisms, though they were lessened in intensity, to a slight degree.

Conclusions.

What conclusions are we justified in drawing from such results as those obtained in the experiments here reported?

(1) It is seen that under the most favorable conditions a given amount of sublimate has the property of rendering inert only a certain number of individual organisms. That is to say, the process is a definite chemical one, taking place between the protoplasm of the individual bacteria and the sublimate in the solution.

(2) That the disinfecting activity of the sublimate against organisms is profoundly influenced by the proportion of albuminous material contained in the medium in which the bacteria are present.

(3) That the relation between the golden pyogenic staphylococci and sublimate is not a constant one, organisms from different sources and of different ages behaving differently when exposed to the same amount of the disinfectant, for the same length of time.

(4) That the organisms which survive the exposure to the sublimate, may experience a temporary attenuation. This attenuation, however, may be caused to disappear by successive cultivation in normal media.

(5) That by the method employed in these experiments it is possible to select from a culture the most resistant forms in that culture.

(6) That many of the results of previous experimenters, who have assigned to corrosive sublimate more powerful disinfectant properties against the staphylococcus pyogenes aureus in cultures than the observations reported in this paper indicate, are attributable to the neglect of certain precautions now recognized as essential to the proper conduct of such experiments.

In the light of these experiments and those of the experimenters quoted in this paper, it is plain that for use in surgical practice the solutions of corrosive sublimate do not possess all of the advantages hitherto attributed to them.

To the employment of sublimate solutions upon wound-surfaces it is plain that there exist at least two serious objections.

First, the albumen of the tissues and fluids of the body tends to diminish the strength of, or indeed renders entirely inert, the solution employed.

And second, the integrity of the tissues is materially injured by the application of solutions of this salt.

The first objection cannot be met with certainty, for the surgeon possesses no means by which he can determine the amount of albuminous material with which his solutions are to come in contact, and in any case this large amount of albuminous material is an almost insuperable obstacle to complete disinfection with sublimate. He is, therefore, never in a position to say, *a priori*, that his efforts at disinfection of the wound are or are not successful.

The second objection is equally serious. During the past two years we have had sufficient evidence to lead us to believe that the normal tissues and fluids of the body possess the power of rendering inert many kinds of organisms which may have gained access to them. This function is therefore diminished, or, indeed, may be quite destroyed, by any agent which brings about alterations in the constitution of these tissues. We know that just such changes as those to which we refer are known to follow the application of sublimate solutions. It is plain then if we bring about in these tissues a condition of superficial necrosis, the condition following upon the application of sublimate, they are much less able to resist the inroads of infectious organisms than they would have been had they been left in their natural condition.

As a disinfectant, in the strict sense of the word, there are perhaps few substances which possesses the property in a higher degree than does corrosive sublimate, but at the same time there is nothing which is employed for this purpose that requires greater care in its manipulation in order to obtain its best results than does this salt. As we have seen, its action is influenced by a number of conditions which in practical application it is difficult, if not quite impossible, to control.

For these reasons we seem hardly justified in continuing to give to it the first place in the list of substances which may be employed practically for the purpose of rendering harmless, materials containing the germs of infectious maladies.

THE JOHNS HOPKINS HOSPITAL REPORTS.

Volume I, for 1889. (The publication of this volume has been postponed for several months owing to the time required for the preparation of additional plates.) It will contain the studies from the Pathological Laboratory.

There will appear articles on the following subjects: hemorrhagic infarction, repair of intestinal suture, reversal of the intestine, extirpation of the thyroid gland in dogs, the effects of artificial heat upon animals, hog cholera, behavior of bacteria in water, bulbar paralysis, cerebellar sclerosis.

The volume will be provided with illustrations.

It will be edited by Dr. W. H. WELCH, Professor of Pathology and Pathologist to the Hospital.

Volume II, for 1890. The second volume of the Hospital Reports began in January, 1890. They will contain pathological, medical, surgical and gynecological papers, and reports, details of cases, the technique of operatins, etc. Subscriptions will be received for the volume of about 500 pages, at $5. The price of the separate fasciculi will vary with their size and the number of plates they contain.

The following numbers of this volume are now ready:

No. 1.—Price, 50 cents.—Contents.

I. On Fever of Hepatic Origin, particularly the Intermittent Pyrexia associated with Gallstones. By WILLIAM OSLER, M. D.

II. Some Remarks on Anomalies of the Uvula, with special reference to Double Uvula. By JOHN N. MACKENZIE, M. D.

III. On Pyrodin. By H. A. LAFLEUR, M. D.

IV. Cases of Post-febrile Insanity. By WILLIAM OSLER, M. D.

V. Acute Tuberculosis in an Infant of Four Months. By HARRY TOULMIN, M. D.

VI. Rare Forms of Cardiac Thrombi. By WILLIAM OSLER, M. D.

VII. Note on Endocarditis in Phthisis. By WILLIAM OSLER, M. D.

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I. Tubercular Peritonitis. By WILLIAM OSLER, M. D.

II. A Case of Raynaud's Disease. By H. M. THOMAS, M. D.

III. Acute Nephritis in Typhoid Fever. By WILLIAM OSLER, M. D.

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Report in Gynecology, I. By HOWARD A. KELLY, M. D.

This contains tabulations of laparotomies, of gynecological operations and urinary examinations, etc., also a description of the operating room and papers on the following topics: composite temperature and pulse charts of forty cases of abdominal section, the management of the drainage tube in abdominal surgery, the gonococcus in pyosalpinx, tuberculosis of the Fallopian tubes and peritoneum, ligature of the trunks of the uterine and ovarian arteries as a means of checking hemorrhage from the uterus, carcinoma of the cervix uteri in a negress, elephantiasis of the clitoris, kolpo-ureterotomy (incision of the ureter through the vagina for the treatment of ureteral stricture), etc.

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The Treatment of Wounds, with especial reference to the Value of the Blood Clot in the Management of Dead Spaces.

No. 6 is now in press. It will contain:

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PROCEEDINGS OF SOCIETIES.

THE JOHNS HOPKINS HOSPITAL MEDICAL SOCIETY.

Meeting of February 2nd, 1891.

Dr. OSLER in the chair. 57 members present.

Cases of Necrosis of Lachrymal Sac.—Dr. RANDOLPH.

The three cases which I present this evening are especially interesting as they illustrate three stages toward recovery, the older case indeed is practically well. The first case came into the clinic about seven weeks ago, the second case four weeks ago, and the boy has been under treatment only ten days. In each case there was an abscess over the site of the lachrymal sac and a fistulous opening leading into the sac. In all three cases, a probe when passed through the fistulous opening, revealed necrosis of the bony walls of the sac.

The first case is of additional interest, because an attempt was made to bring about healing by simply opening the abscess and scraping away the necrosed bone with a spoon. I removed some particles of dead bone and introduced a tent. I found, however, that this method of procedure, while it relieved him of the pain and tension, did not put a stop to the epiphora, nor did the fistula show any disposition to heal up. I determined then to open up the canaliculus and pass in regularly graded probes. The probes I have here were devised by Doctor Theobald. They are made of aluminum, and are consequently light, and are by far the best probes I have ever used. There are sixteen of these probes ranging in size from one quarter of a millimetre to four millimetres. I have just introduced a No. 16 probe in the first case and it will be observed that it can be passed well through the nasal duct and withdrawn with little or no effort on the part of the operator. The fistula in this case healed up after two weeks' treatment and the lachrymal apparatus generally presents a normal appearance. The epiphora has also disappeared.

The second case has improved markedly, the swelling has gone down and the fistula closed up. This patient is getting a No. 13 probe.

The first case I regard as cured, and I expect to have the second case equally benefited in a short time. The last case shows precisely what was present in the first of these cases seven weeks ago, namely, a typical lachrymal abscess with fistula. This patient, too, is steadily improving.

The treatment differs from that practised on the Continent and in Great Britain, in that the probes used are much larger, and it is just in this point that lies the success of the treatment and the advantage that these probes have over others. The canal should be dilated to its utmost anatomical capacity. Bowman's probes are generally used abroad, and his largest probe corresponds in size to Theobald's No. 8, and I have introduced this probe month after month in the eye clinics in Vienna, and have only given incomplete relief; and such was generally the history of the cases treated with Bowman's probes. There are cases no doubt where it is not possible to introduce a No. 16 probe, but this is not so in the majority of cases, indeed I find it the exception, where one can not eventually pass a No. 16 with ease, and that, too, in young children. I commence with a No. 6 and introduce a probe twice or three times a week increasing the size by one number at every visit till a No. 16 is reached. After the largest size probe can be introduced with ease, as is the case here, the intervals are gradually lengthened, till finally, only three or four visits in a year become necessary.

Case of Multiple Cysticerci.—Dr. OSLER.

Man not only harbors tape-worms but in exceptional cases acts as an intermediate host in which the eggs develop into the larvae, or cysticerci. The cases of this kind have been of the *taenia solium*. If the subject of a tape-worm, a man may be infected when a ripe segment wanders into the stomach, or, in prolonged vomiting, is driven there by antiperistalsis. Or he may, as does the pig, ingest, accidentally, an ovum or two, or occasionally an entire segment. In either case the eggs are digested in the gastric juice and the six hooked embryos are set free. Burrowing through the walls of the stomach and intestines, and entering the blood vessels as well, they finally lodge in the muscles or sub-cutaneous tissue, and in the solid organs, in which they develop into the little bladder worms or cysticerci. The condition is not very rare in man, but the cysticerci as a rule are few in number. Very many instances have been described in the vitreous humor of the eye and in the brain. The condition is only serious when a man ingests a large part of a segment, or when a cysticercus develops in some vital part, as in the fourth ventricle. They do not often cause symptoms; a majority of the cases have been described by oculists.

The case which I present this evening is of interest, partly on account of the unusual number of cysticerci which may be felt in the sub-cutaneous tissue and in the muscles, and partly because they produced very positive symptoms. The notes of the case are as follows:

George K., aged 43, German by birth, a laborer, was admitted January 27th, 1891. He has never been a butcher. There is nothing of interest in his personal or family history. He has been in this country for five years. He has never had a tape-worm. Three months ago he began to have pains in the arms and legs, which were specially felt on muscular exertion. He found that he could not walk rapidly and became tired, and, as he expressed it, "he felt as if his legs were cut off at the ankles." He describes the pains as shooting in character, severe, and much increased by muscular exertion. There were also numbness and tingling in the finger tips. At night the legs and arms sometimes jerked when the pains shot through them. Sometime after this he noticed the occurrence of small nodules beneath the skin, which were painful on pressure and on exertion. The condition gradually became so serious, that he had to give up work, and for a week previous to admission the stiffness and disability became very marked. On admission he had to be helped upstairs and into the ward, as he could not walk unaided.

When the history was read to me the case seemed to point definitely to a spinal trouble, or, possibly, to a peripheral neuritis. On examination, the following notes were made:

"He is a healthy looking man, with well-developed muscles; face much scarred with small-pox. The examination of the thoracic and abdominal viscera is negative. He stands well, the hands and feet are somewhat congested; walks with a slow, somewhat stiff gait, not at all characteristic of any spinal affection. The grasp of the hands is much enfeebled. The patient drew our attention to nodules in various parts of the body, beneath the skin, which vary in size from a grain of fine shot to a very large pea. They are not in, but beneath the skin, and, to some extent, can be rolled about upon the muscles. He pointed out to us one over the right deltoid, two immediately below the ribs in the left lumbar region, a small one on the left thigh, and several smaller ones on the shins. Those in the arms, on pressure, are extremely painful, particularly one just within the arm-pit. Grasping the muscles seems also to cause him pain." In discussing the nature of these multiple sub-cutaneous tumors, the possibility of their being cysticerci was suggested by Dr. Lafleur. One of the nodules was removed and found to be a cyst, the size of a large pea, containing the *cysticercus cellulosae*, the hooklets and sucking disks of which were perfectly distinct. The examination of the eyes was negative; no cysticerci could be seen in or beneath the tongue, a situation in which, from the presence of cysticerci, the disease may sometimes be diagnosed in the hog.

Seventy-four cysticerci were to be counted, in various parts of the body, chiefly upon the trunk. The largest was in the right axilla. Two were just below the lower edge on the right side. Several of the more painful of the tumors have been removed and they all presented characters identical with the first.

In this case the pains and weakness were directly due to the invasion of the muscles by the parasites. In all probability he has accidentally ingested a considerable portion of a ripe segment, and has a very large number of the parasites in his muscular system. I reported some years ago upon this condition in calves, termed by Leukart *cestode tuberculosis*, and have produced it experimentally by feeding them with ripe segments of the *taenia saginata*. In the invasion stage the calves show just such stiffness of the muscles as presented by this patient.

There are no symptoms pointing to invasion of the brain, or of the cord, so that the outlook for the patient is good. The larvae will, after a certain length of time, die and undergo calcification. In this condition they are sometimes found in the muscles post-mortem or in the dissecting room, not so frequently, however, as the calcified trichinae. I have only once met with the calcified cysticerci.

[The subsequent history of the patient may be here mentioned. He improved rapidly, the stiffness disappeared, he gained in weight and strength, and was discharged March 17th.]

A Case of Conservative Caesarean Section.—Dr. Kelly.

I here present to the Society my fourth Caesarean Section, the first three performed in Philadelphia, and this last in the Johns Hopkins Hospital; all of them have been successful in saving both mother and child. Two of these cases were operated upon under an absolute indication, the Caesarean operation being imperative, in one instance on account of extensive pelvic cellulitis,[1] the woman having been in labor two weeks, the second case being absolutely necessary on account of a large bony tumor choking the pelvis.[2] The other case was operated upon for a relative indication, as it would have been easy to have performed craniotomy.[3] The present patient, whom I here show the society, was also operated upon under a relative indication.

Mrs. D. is a patient of Dr. R. H. Smith of Havre de Grace, Maryland. She is Irish by birth, 36 years of age, weighs 115 pounds, is 132½ cm. in height. Her massive face, long body, flat pelvis and curved thighs show that she is rachitic. She was quite well as a baby, and until her eighth or ninth year, when she was paralyzed, after which it was quite a while before she could work again. In July, 1887, she had her first child at term. Craniotomy was performed and a dead foetus was delivered by Dr. Smith with extreme difficulty. On the 27th of August, 1888, she was again delivered after a frightful labor, lasting fourteen hours, when she took ether and a dead child was forcibly extracted. She was so ill after this that she was not expected to recover. She menstruated last in April, 1890. The time calculated for this present labor was January 20, 1891.

Pelvic measurements were: anterior superior spines, 23 cm., crests of the ilia, 26 cm., Baudelocque's diameter, 19 cm., conj. diag., 9 cm., conj. ver. estimated at 7.5 cm. The head was floating high up above the brim of the flattened contracted pelvis in the first position. The breech lay in the right hypochondrium. She was seen by my friend, Dr. L. E. Neale, who concurred with me in my opinion. She fell into labor January 16, 1891, a week earlier than expected. After six hours of hard labor pains, the large head still remained above the pelvic brim, just as movable as at the beginning.

Caesarean section was determined upon from the character of the previous labors, as well as the evident, marked disproportion between the fully developed child in utero and the contracted pelvis.

I am indebted to Dr. D. M. Reese, who stood by, for the following accurate steps of the operation performed January 16, 1891.

Exact time incision made in the skin, 4.17.45 p. m. Length of abdominal incision, 16 cm. Exact time of incision into uterus, 4.18 p. m. Estimated uterine incision uncontracted, 20 cm.; contracted 13 cm. No placenta previa Caesarana? Amount liquor amnii, 800 to 1000 cc. Child caught by left arm, dropped and caught by breech and extracted. Exact time of delivery of child, 4.18.45 p. m. Delivery of placenta attached posteriorly, 4.19.45 p. m. Duration of suture of uterine wound, began 4.20.45, ended 4.27.45. Number of deep uterine sutures, 7. Number of half deep sutures, 8. Exact time began to close abdominal incision, 4.30.58 p. m. Number of deep abdominal sutures, 10. Number of superficial abdominal sutures, 10. Time of complete closure, 4.39.5 p. m. Time of last deep suture tied, 4.36 p. m. Time of last superficial suture tied, 4.39.5 p. m. Complete length of time of whole operation from first incision to tying last superficial suture, 21.45 minutes. Pulse of mother at 4.21.5, during operation, 68 regular and volume good. Hypodermic of Ergot, 15 minims, given at end of operation. Quantity of anaesthetic (Chloroform), 50 cc. Began chloroform at 4.10 p. m., stopped chloroform at 4.40 p. m. Foetal pulse before operation 144, at birth 168.

The child was thus born 1 minute after the operation was begun, and I began to suture and close the uterine incision 3 minutes after the beginning of the operation.

The duration of the operation down to complete closure of the uterus, was 10 minutes.

The duration of the whole operation down to the complete closure of abdominal incision was 21¾ minutes.

Every preparation had been so carefully made beforehand that not a moment's time was lost in proceeding from step to step, and the whole operation was completed with despatch, although without any undue haste.

The patient's pulse was 72 before the operation, 68 once during the operation, and 72 after, which was satisfactory evidence that there was no shock.

The child, a male, was born slightly cyanosed, crying as he came out of the incision. His pulse at birth was 168, 24 beats quicker than in utero. A half hour after birth the pulse was 158. He assumed the normal pink color within 5 minutes.

There was no apnoea due to the rapid delivery. The flexed child measured 24 cm. in length and extended 49 cm. from heel to vertex.

Head measurements were: occipito-mental diameter 14 cm., exactly as calculated previous to birth, circumference 35.5 cm. Occipito-frontal diameter 11.6 cm., circumference 34 cm. Sub-occipito breg. 10.5 cm., circumference 31. Biparietal diameter, 9 cm. Bitemporal diameter, 8.25 cm. The head was beautifully rounded, owing to absence of moulding. The exact weight of the child was 3175 g., equal to 7 lbs.

The mother made an excellent recovery in every way, her highest temperature being 100.4° on the second day. After this, it did not reach 100° at any time.

The sutures were removed in six days. Union was perfect throughout. She nursed the baby from the second day on. She returned home February 14, and has since written that she is in perfect health.

Cases Treated by Koch's Method.—Dr. Morison.

[See *Bulletin* for February, No. 11, p. 38.]

Spurious Ankylosis of Jaws.—Dr. Halsted.

Dr. Halsted exhibited a patient upon whom he had operated successfully for the cure of spurious ankylosis of the jaws, and said: "This little boy, aet. 14 years, was profoundly salivated when he was five years old. The ulceration from the mercurial inflammation was so extensive that all of the mucous membrane lining the left cheek was destroyed. Several pieces of bone were exfoliated from the upper and lower jaws on the left side. In two years the sores were completely cicatrized. During the entire process of cicatrization the boy wore a piece of rubber between his teeth. Notwithstanding this precaution the boy could not separate his incisor teeth more than one cm. when he presented himself six years ago to a Baltimore surgeon for operation. The operation was not a successful one, for, when admitted to this hospital, October 13, 1890, the incisor teeth could not be separated more than about 0.5 cm. We have performed three operations upon the boy and now he is permanently cured.

Operation I. October 16, 1890. An incision, from the left angle of the mouth to the anterior border of the masseter muscle, was made through the skin of the cheek and through the dense connective tissue which bound the jaws together from about where the canine teeth might have been back to the anterior border of the ramus of the lower jaw. We were then confronted with two raw triangular surfaces which we had made. These surfaces, one above and one below, were, of course, parallel to each other until the jaws were forced apart. The jaws having been forced apart, the planes of these surfaces had an inclination of about 45°—the bases of the triangles meeting at the fornix of the jaws, and the apices, corresponding to the angle of the mouth, being widely separated. A large piece of mucous membrane taken fresh from the cheek of a dog was transplanted to the raw triangular surfaces and held in place by stitches.

October 27th. For seven or eight days it seemed as if a portion, at least, of the transplanted mucous membrane had become attached, but to-day it is certain that the entire graft is dead. It is accordingly removed.

Operation II. November 4, 1890. The granulations covering the triangular surfaces were shaved off with a scalpel and the fresh raw surfaces were covered according to Thiersch's method with three or four grafts of skin. The grafts were held in place by fine needles used as tacks. The gutta-percha tissue and the gauze pads were also held in place by the needles.

November 8th. The dressing is removed. The grafts have taken perfectly.

December 1st. The boy can separate his incisor teeth about 3.5 cm.

The ankylosis mandibulae is permanently cured; for the raw surfaces have been so completely covered with skin that no adhesions and no contractions can take place.

Operation III. December 2nd, 1890. To close the cleft of the cheek, a horizontal incision was made through the skin of the left cheek a little below the inferior margin of the left orbit. From the extremities of the horizontal incision two vertical incisions were made. The anterior vertical incision extended to the angle of the mouth; the posterior to the outer extremity of the cleft in the cheek. The flap of skin so defined was reflected down to

[1] *V. Med. News*, Phila., Sep. 22, 1888.
[2] *V. Med. and Surg. Reporter*, Phila., Jan. 25, 1890.
[3] *V. Amer. Jour. Obs.*, Vol. XXIII, April, 1890.

close the defect in the cheek. The skin surface of the flap was turned towards the mouth, and the raw outer surface of the flap was covered with skin, transplanted according to Thiersch's method.

The boy can now, as you see, open his mouth quite naturally. I am sure that he is permanently cured. I think that the case is one well worth presenting to the society; for such cases are rarely much benefited by operation, and this case has been cured by a new and not very difficult method.

A New Needle-Holder.—Dr. Williams.

Dr. Williams exhibited a needle-holder which he had devised and said: Some of the various forms of needle-holders devised for Hagedorn needles fulfil all the requirements of a perfectly antiseptic instrument and leave nothing to be desired in that respect. But they are only adapted to the use of Hagedorn needles and cannot be used with the ordinary curved surgical needles, which are still used by many. Holders for this class of needles offer a large field for improvement; for I know of but few needle-holders, with any sort of spring catch, which are not made with several screws or permanent joints, which cannot be removed and cleansed, thereby placing the instrument in the category of uncleanly instruments.

Fig. 1.

Fig. 3.

Fig. 2.

The following needle-holder is a modification of one devised by Professor Zweifel, of Leipzig, and differs from it only in the fact that all its parts are readily separable, instead of being permanently united as in his instrument.

The instrument presents the general form of most holders for flat needles and is provided with a spring catch at the end of a handle, and is represented in *Fig.* 1.

The blades are provided with a shouldered French lock and are readily taken apart (A); the jaws are lined with copper to prevent slipping of the needle. The main improvement presented by this instrument is the spring (B) and catch (E) which can be readily removed for cleansing and whose form is readily seen in the drawings.

Instead of by a rivet, the catch is attached to the lower blade as follows: The axle is firmly placed at the lower part of the catch as shown at (F); and instead of a mere rivet hole at the end of the lower blade, we have the slot (G) into which the axle is placed as shown in *Fig.* 3. The catch is then turned up into its normal position and is held in place by the end of the spring (B). The spring is provided with a fenestrum, which slides under the knob (D), by which it is held in place. It is placed in position by placing its small end under the end of the catch (*Fig.* 1) and then pushing the fenestrum firmly under the knob (D). The upper blade is then placed in position and the instrument is ready for use.

The instrument has proved itself of practical value and offers no difficulty in taking apart and cleansing.

I do not pretend to claim any great amount of originality for the instrument, for it is merely a combination of several forms; but I do claim that it is perfectly cleanly and fairly simple in its construction.

The instrument was made by Mr. Chas. Willms, to whom I wish to express my thanks for the able manner in which he carried out my instructions.

Drawings five-ninths size of instrument.

Dr. Halsted asked Dr. Williams if needles curved on the flat were ever to be preferred to needles curved on the edge—to Hagedorn's needles. Dr. Williams replied that he preferred the ordinary needles merely because he had always used them.

Dr. Halsted:—"Of the very many surgeons who use the so-called Hagedorn's needles, there are probably not a few who do not understand the peculiar advantages of them. I am quite sure of this because of the popularity of a certain holder which defeats the very object of the needle which it is designed to hold.

The ordinary strongly curved needles—needles curved on the flat—must be grasped by the needle-holder in such a way that one jaw of the holder presses the concave side of the needle at two points and the other jaw presses the convex side of the needle at an intermediate point. If it be necessary to exercise much pressure the needle grasped in this way may readily be broken.

Inasmuch as strongly curved needles are used as a rule only for the application of more or less difficult stitches—of stitches in the deeper recesses of wounds—the breaking of such a needle just before the completion of a stitch may be very annoying.

Hagedorn's needles are curved on the edge and flattened on the sides. They cannot, except with great force, be broken by a holder which grasps them properly—which grasps their straight, flat sides.

New holders for Hagedorn's needles are devised almost every year. One of the holders, the most popular one perhaps in this country, was devised about six years ago by a New York practitioner. It grasps the needles by their curved edges and thus exposes the needles to the very danger which they were devised to prevent.

Twenty years or more before Dr. Hagedorn described his needles it had occurred to Dr. Joseph Schnetter, attending surgeon to the German Hospital, New York, to devise not only needles precisely like the so-called Hagedorn needles but also a needle-holder essentially the same as that which Dr. Hagedorn regards as his improved needle holder.

A few years ago I saw Dr. Schnetter's original needle-holder among the instruments of the German Hospital, and was informed that it had seldom been used by any one except the inventor."

Case of Amœba Coli.—Dr. Lafleur.

[To appear in the next number.]

Meeting of February 16th, 1891.

Dr. Osler in the chair. 39 members present.

Exhibition of Cases.—Dr. Halsted.

Dr. Halsted exhibited ten cases of hernia where a radical operation had been performed in accordance with the method described in the *Bulletin*, No. 1, Vol. I.

Tuberculosis of Knee.—Dr. Flexner.

J. W., colored, æt. 20, came into the Hospital on November 11, 1890, suffering from a large, swollen right knee-joint. He gave briefly the following history: The knee began to pain him two years ago, following a fall. There is no phthisical history. The pain in the knee is inconstant, and the swelling came on gradually.

On November 14, 1890, the knee-joint was opened and a quantity of caseous

pus evacuated. On November 29, 1890, the wound was found to have healed, excepting a line of granulations along a part of the track of the incision.

On December 13, 1890, the patient received an injection into his back of two milligrams of Koch's lymph. On December 17, 1890, a similar quantity was injected, and again on December 20. On December 22, 1890, the patient was given three milligrams by injection, this being the final dose. In all he had four injections of the lymph, amounting to 9 milligrams.

The patient had the characteristic reactions following the injection. On January 2, 1891, his temperature was still elevated, and on that day a small fluctuating spot was detected in the lower angle of the wound. On January 4, 1891, this opened spontaneously and some cheesy material was scraped out of the opening. This material was examined for tubercle bacilli, and it was found to contain them in considerable numbers. The opening communicated with the cavity of the joint.

On January 12, 1891, the wound was injected with iodoformized oil, and on January 22, 1891, the joint was opened and resected.

Description of the tissues removed by Dr. Halsted from the knee-joint of J. W., colored.

The tissues removed consisted of the lower end of the femur, the upper portion of the tibia, the patella, and a quantity of loose and less definite material. On macroscopical examination, the cartilage was seen to be entirely absent from the inner condyle of the femur, its place being supplied by a layer of granulation tissue studded with small grayish points. Around this granulation tissue an elevated, transparent and oedematous tissue was to be seen. The inner condyle retained its cartilage almost entirely, but the cartilage in this situation was white, thickened and easily removable, and below the cartilage was a more transparent tissue filled with miliary tubercles.

The tibia was, in the main, in the same condition as the femur. The cartilage was absent over the inner articulating surface, while over the external surface it was only partly gone. The cartilage which remained on the external surface was thickened and easily removable, and likewise beneath the removed cartilage was a mass of tubercular tissue.

The patella was denuded of cartilage excepting at one small point. The cartilage which remained was thickened and roughened, and its edges were slightly elevated. Beneath the cartilage was a layer of granulation tissue covered with tubercles. Surrounding the patella was an elevated mass of oedematous-looking tissue which contained on and beneath its surface distinct caseous masses.

The cut surfaces of the bone showed nothing of especial interest save a greater rarefication, perhaps, than is normal. The tissues around the joint consisted of an oedematous granulation tissue and tuberculous tissue.

The soft parts removed were examined microscopically and sections were made from the various tissues. The first of these was from the tuberculous sinus leading into the joint, and it embraced the skin above and the tissues about the sinus. The sinus is shown to have been lined by a tubercular tissue which extended for some distance beneath the skin. This tissue consisted of both a tubercular tissue and of large tubercles, and in it there is evidence of extensive necrosis.

All along the edge of the sinus an acute inflammatory process is shown to have been present and the tissues at this place are invaded by polynuclear leucocytes. Some of the deeper tubercles contain polynuclear leucocytes, but the chief weight of the inflammatory process is seen to have been on the surface.

The second sections came from the capsule of the joint, from a point where an area of necrotic tissue, surrounded by a rather vascular tissue, could be made out on the surface macroscopically. The sections show a large area of necrosis apparently old, which is surrounded by a layer of miliary tubercles. The tissue in which the tubercles are imbedded does not show any especially active process. A few leucocytes are to be seen in the edges of the caseous material, but the entire appearance is not essentially different from the picture usually observed. Leucocytes are not to be seen around the outside vessels and there is no evidence of an especially active process at this point. There is a marked endarteritis affecting all of the arteries in these sections.

The third specimen was taken from a portion of the joint in which tubercles and caseous areas could be made out macroscopically. These sections show a considerable amount of granulation tissue rich in cells around the single tubercles. Some of the tubercles are quite caseous, whereas others are caseous only in the centre. There are numerous leucocytes in the tissue and they are seen to have entered the caseous masses in considerable numbers in places. However, even in this specimen, there is no especial necrosis or demarcating inflammation separating the tubercles from the rest of the tissue, and the general process is not very different from the one often observed in these cases.

The fourth specimen came from the capsule of the joint also, and it shows a large amount of tuberculous tissue with scattered giant cells and occasional miliary tubercles. The surface is covered with a diffuse tuberculous tissue and the blood vessels beneath the surface are numerous and dilated. The dilated vessels contain a large number of polynuclea leucocytes, these being especially abundant around and in the vicinity of the vessels, and they are seen to have entered the tuberculous tissues in considerable numbers in places. In the edges of the tuberculous material are masses of fragmented nuclei which were doubtless derived from the leucocytes. The only change in this specimen from what one ordinarily sees is an acute inflammation in a tuberculous area. As far as can be determined there is no evidence of an especial action exerted on the tubercles themselves and the necrosis in the tubercles is not more advanced than is often observed.

The fifth specimen was taken from a place in the joints where great caseation of tissue was visible to the naked eye. Sections made from this specimen show the most extensive tuberculosis; they are diffusely caseous with occasional tubercles and tuberculous tissue; they show considerable leucocytic infiltration in places, but beyond this nothing of importance.

The sixth specimen came from the smaller and oedematous tissue around the patula. In it are masses of miliary tubercles, single large tubercles and large caseous areas. There is great necrosis in this specimen and in one tubercle what appear to be a distinct local softening. In this the central tissue is broken down and filled with leucocytes many of which have undergone fragmentation. Immediately beneath the surface of the joint and along the few vessels between the caseous masses numerous leucocytes are seen to have entered the necrotic tissue. The small cell infiltration is marked about the tubercles, but it cannot be said to be more extensive than one frequently finds. Nearly all of the arteries in this specimen show an obliterating endarteritis.

The seventh specimen was taken from the tissue around the patella in which there were few distinct tubercles, but more tuberculous tissue. Viewed as a whole, the tissue in this portion is very poor in cells, the vessels are scant, around many there is an infiltration with leucocytes; the arteries are the seat of an obliterating endarteritis, and the intercellular tissue is seen to be necrotic beyond the limits of the tubercles.

The eighth specimen represents a layer of necrotic tubercular tissue which extended all along the edge of the joint. In parts of this specimen numerous leucocytes are seen which would seem to have entered in the most part from the joint cavity. Beneath the part invaded with leucocytes are tubercles surrounded by masses of granulation tissue without special evidence of inflammation.

The ninth specimen shows a large amount of softening and disintegration of the caseous tissue lining the joint, together with many leucocytes in the tissue beneath.

The tenth, eleventh and twelfth specimens show nothing that has not already been noted.

The bacteriological examination showed in the pus evacuated spontaneously, as previously mentioned, many tubercle bacilli. In the tissue very few tubercle bacilli were found. In one of the specimens small masses as well as single bacilli were present, and these were in a part in which the caseous area was in communication with the opening of the wound. Usually the bacilli were found singly or in small groups of two or three, and even this was the case in only a few sections. The search for other bacteria in the sections proved entirely negative.

It seems probable from this examination that the whole process as here observed is to be regarded as an active and very extensive tuberculosis of the joint combined with suppuration. The tuberculous tissue is in the form of both miliary tubercles and diffuse tuberculous tissue with giant cells. Many of the miliary tubercles are exceedingly small and apparently in the stages of active formation, and this would tend to show an active advance of the tuberculous disease.

Although the necrosis is extensive in some of the larger areas it is difficult to say that it is the result of any specific process. For one finds necrosis just as extensive as in this case in tuberculous joints ordinarily. Again, an acute inflammation with invasion of the tissues by leucocytes is marked in places, and there has been a similar invasion of the caseous mate-

rial lining the joint, the latter leucocytes having entered from the joint cavity. But this inflammatory process is distinctly local, many of the tubercles show no inflammation around them, and there is no process of sequestration of the tuberculous masses whatever by the action of a purulent inflammatory process. Hence the case would, under ordinary circumstances, be regarded simply as a rapidly advancing tuberculosis of the joint combined with suppuration.

In conclusion, I would express my indebtedness to Dr. Councilman for his valuable assistance in describing this case.

A Case of Pseudo-Chorea.—Dr. Hoch.

Gentlemen, I wish to show you a patient who, although almost well now, presented about a fortnight ago a most curious condition.

When first seen at the out-patient department the most conspicuous features about the case were clonic movements of some of the muscles of his trunk, which jerked the latter forcibly to the right side, the diaphragm being affected at the same time, so that a grunting inspiratory sound was produced which often interrupted his speech in a quite characteristic manner. His gait was hemiplegic and the muscular strength was found to be distinctly subnormal on the entire right side, the movements were confined to the trunk and followed each other in quick succession. The motions of the limbs were found only to be communicated. The man was totally unable to walk alone.

As regards his family history, we were told that the patient's father had died with an acute brain-trouble, the exact nature of which, however, could not be ascertained. The patient had been well and strong. No excesses *in Baccho aut Venere*. No syphilis. In 1888 he entered the army. In 1889 he was in Washington Territory with his regiment and much exposed to wet and cold. During the next summer, following a good deal of exposure, he was attacked with severe pain in his back, which shot down into his legs, especially the right one to the toes. The joints were neither swollen nor red, but the attack was of considerable severity, so that, as he states, he was unable to walk for between two to three months. While still at the hospital, he had an attack of the same nature as the present one, which persisted for four months and gradually disappeared. With the exception of a very slight return in the spring of 1890, he remained perfectly well until 15 days before he was first seen. While driving a wagon the axle broke and he was thrown out. He was not hurt, but two hours later the jerking movement referred to above suddenly appeared.

Two days after presenting himself at the dispensary he was admitted to the hospital, the condition was then slightly better. A more careful examination was made. The latissimus, dorsi., the rhomb., the serrat., were found to be especially affected. The pectoralis less so. Of the abdominal muscles the rectus. The diaphragm as stated above. The weakness of the right side still well marked. Some tenderness over the errect. spinae.

About the movements the note, which was dictated by Dr. Lafleur, says: "the movements are of great rapidity and have almost a rhythmic character jerking his body to the right in a manner which reminds one somewhat of the canine chorea."

The viscera showed no changes.

He was found to have dulling to sensation of pain (not of touch or of heat) in the whole right side with the exception of the face. There is diminution in the reflexes on that side. The perimetric fields of both eyes were equal and normal. The special senses are in no way affected. Electrically there was no change found.

The patient was placed in a room by himself and no medication save a placebo was given.

The improvement was rapid and remarkable. He slept comfortably, the jerks diminished in frequency and four days later only occasional movements were observed, and still three days later they had almost completely ceased. Now the only features remaining are the sensory changes and the changes in the reflexes. The resemblances to Sydenham's chorea exist of course only in a rough way. The points which are unlike the true chorea, are: (1) the almost rhythmical character of the movements; (2) the electric-like character of them; (3) the fact that they were confined to the trunk; (4) the sensory changes; (5) the fact that in a quite short time the movements reach the greatest severity.

The case, therefore, must be classed under the head of Pseudo-chorea, which belongs under the large heading of Hysteria.

HOSPITAL HISTORICAL CLUB.

Meeting of January 12th, 1891.

Dr. Welch in the chair. 29 members present.

Dr. Kelly read a full abstract from Dr. Mece's book on the History, Development and Manufactories of Philadelphia, 1811; particularly the portions relating to physicians, hospitals and medical institutions. And illustrated the comparative size of Philadelphia in 1811 and 1891 by a diagram.

Following this, Dr. Kelly read abstracts from "Historical Sketches of Virginia," 1852, by Henry How, with regard to a trial for witchcraft in Virginia in 1705, for deformed genitals.

Dr. Osler then read abstracts from John Jones' Manual of Surgery, 1776; also a short sketch of his life.

Dr. Gundry related an anecdote of Dr. Jones, and also called the notice of the club to Dr. Jones' treatment of scurvy by fresh fruit as being the earliest tendency to the correct treatment of the disease.

Dr. Hoch then read short abstracts from the Ebers Papyrus.

Meeting of February 9th.

Dr. Welch in the chair. 25 members present.

The following papers and abstracts were presented:

An old English translation of the Regimen Sanitatis of the School of Salernum. Dr. Welch.

A note on the Introduction of Aspiration for Pleurisy. Dr. Osler.

Extracts from Early Asylum Reports. Sketch of the History of the Site of the Hospital. Dr. Hurd.

D. Meredith Reese,
Secretary.

NURSES' JOURNAL CLUB.

[The first meeting of the Nurses' Journal Club was held in the library of the Nurses' School, at eight, p. m., January 28th, 1891. The object in organizing this Club was to promote a feeling of *esprit de corps* among the members of the School, to keep in touch with what is being done in other schools and hospitals by means of reports and discussions drawn chiefly from English and American weekly and monthly nursing magazines, and to ensure a reading of such papers by all. The spirit of the Club is entirely informal, the only official position being that of chairman, whose duties are to call meetings and to appoint those who are to take part from evening to evening. As the Club is to be a recognized organ of the School, the attendance upon the part of the pupils is obligatory; but only the staff of head-nurses, the senior pupils, the superintendent and assistant superintendent, are expected to prepare or read papers; the junior members join in the questions and discussions.

Three papers are given during an evening, and twenty minutes are allowed to read and discuss each. One is a report from the weekly journals; the second, selections from the monthly journals; and the third, an original paper or selections from any medical magazine touching upon any subject of interest to nurses. The Club meets every second Monday evening for one hour.]

At the five meetings held the following subjects were presented and discussed:

Meeting of January 28th, 1891.

Address on the Scope and Aims of the Johns Hopkins Medical School. Miss Hampton.

Original paper. The Qualities of a Nurse. Miss Nutting.

Report of the Koch Treatment of Tuberculosis in Berlin. *Abbott.* (*Johns Hopkins Hospital Bulletin.*) Miss McKechnie.

Meeting of February 11th, 1891.

The Koch Treatment of Tuberculosis. *Morell Mackenzie.* (*North American Review.*) Miss Richart.

Extracts from open Letters by Cardinal Gibbons, Mary Putnam Jacobi, C. F. Folsom, W. Osler. (*The Century.*) Miss Dock.

"Conduct in Private Nursing." *Green.* (*The Nightingale.*) MISS TURNER.

Meeting of February 25th, 1891.

"My Work among the Lepers." *Sister Rose Gertrude.* (*The Nightingale.*) MISS MILLER.
Annual Address to Nurses. *Graham.* (*The Trained Nurse.*) MISS SPENCER.
Extracts from "The Treatment of Acute Lobar Pneumonia." *Fenwick.* (*The Lancet.*) MISS CHASE.

Meeting of March 9th, 1891.

Care of Sick Children. *Chapin.* Practical Hydrotherapy. *Miss Manning.* (*The Nightingale.*) Treatment of Cough. *Bruce.* (*The Lancet.*) MISS ANTHONY.
Ward Management. (*Original Paper.*) MRS. EMORY.
Study of Movements of Stomach, Pylorus and Duodenum. *Rossbach.* (*Am. Jour. Med. Sciences.*) MISS EMORY.

Meeting of March 23d, 1891.

Specialties for Nurses. (*The Nursing Record.*) MISS MAY.
The Care of Eye and Ear. *Rossa.* Surgical Care of Children. *Abbe.* (*The Nightingale.*) Method of giving Sulphonal. (*The Lancet.*) How would you apply and treat a Blister? (*The Hospital.*) MISS DOCK.
Intestinal Anastomosis. *Halsted. Senn.* MISS CLEAVER.

ASSOCIATION OF RESIDENT PHYSICIANS OF THE JOHNS HOPKINS HOSPITAL.

A meeting was held February 12th, at 8 p. m., in the reading room of the Hospital to organize an Association of the Resident Staff of the Hospital, the object being to maintain a bond of fellowship between residents and ex-residents, and to promote an *esprit de corps.*

Officers for the ensuing year were elected as follows:

President.—DR. A. C. ABBOTT.
Vice-President.—DR. J. ALLISON SCOTT.
Secretary and Treasurer.—DR. HUNTER ROBB.
Historian.—DR. H. A. LAFLEUR.
Executive Committee.—DRS. TOULMIN, FINNEY, REESE and THAYER.

The Association is to hold its annual meeting on the 7th of May, the anniversary of the opening of the Johns Hopkins Hospital.

HUNTER ROBB,
Secretary.

NOTES ON NEW BOOKS.

"A Text-Book of Bacteriology," by CARL FRAENKEL, M. D., Professor of Hygiene, University of Königsberg, translated by J. H. LINSLEY, M. D. (*New York: William Wood & Co.*)

This translation of Fraenkel's "Grundriss der Bacterienkunde," as the name implies, is designed as an introduction to the study of Bacteriology.

The contents comprise in the main the course of instruction given at the Hygienic Institute of the University of Berlin. Neither theoretical considerations nor literature are taken up, the body of the text being devoted to practical details.

The first four chapters are devoted to the general methods of investigation basis of morphological classification, microscopic examination of bacteria, methods of cultivation, infection and immunity.

In chapter V are given the characteristics of the more important bacteria of the non-pathogenic variety.

Chapter VI contains a list of the disease-producing organisms with a description of each.

Chapter VII contains methods of air, soil and water investigation. There is also a short appendix in which some of the more prominent moulds and yeasts are described.

This book, which is an octavo of 376 pages, neatly bound in cloth, has already reached its 3d edition, of which the copy before us is a translation. It has been translated into several different languages—which fact alone testifies to its value.

In translating this work into English and editing it so judiciously Dr. Linsley fills a long-felt want.

For those beginning the study of bacteriology there is probably no book which can be more highly recommended. A. C. A.

Dr. JOHN S. BILLINGS, Surgeon U. S. Army and Director of the Hygienic Laboratory, will lecture at the Johns Hopkins Hospital on "Methods of Vital Statistics," at 4.30 p. m., Mondays, April 27th, May 4th, May 11th and May 18th, 1891. These lectures are to be of a practical character, and are designed for those who desire to familiarize themselves with working methods in vital statistics.

THE JOHNS HOPKINS HOSPITAL BULLETIN.

The Hospital Bulletin contains announcements of courses of lectures, programmes of clinical and pathological study, details of hospital and dispensary practice, and abstracts of papers read and other proceedings of the Medical Society of the Hospital, reports of lectures, and other matters of general interest in connection with the work of the Hospital. Nine numbers will be issued annually. The subscription price is one dollar per year.

STUDIES FROM THE BIOLOGICAL LABORATORY OF THE JOHNS HOPKINS UNIVERSITY.

H. NEWELL MARTIN, Ph. D., M. D., Professor of Biology, EDITOR; *W. K. BROOKS, Ph. D., Professor of Animal Morphology,* ASSOCIATE EDITOR.

The publication of the Studies from the Biological Laboratory was commenced in 1879, in order to secure publication in the United States of the results of researches carried out in the Biological Laboratory of the University and in its Chesapeake Zoölogical Laboratory. Most of the original biological work of members of the University since 1879 has been published in these "Studies."

Four volumes have already been issued, and Vol. V. is in progress. Each volume contains about 500 large octavo pages, and numerous plates. The subscription per volume is $5.00: separate numbers may be purchased at a price varying with their size and the number of plates they contain. The first three volumes are now out of print.

The latest papers issued in this series have been:

Notes on the Anatomy of Sipunculus Gouldii Pourtales. By E. A. ANDREWS. 52 pages, 8o, and 4 plates.

The Relationships of Arthropods. By H. T. FERNALD. 82 pages, 8o, and 3 plates.

A Contribution to the Embryology and Phylogeny of the Pycnogonids. By T. H. MORGAN. 76 pages, 8o, and 8 plates.

The Johns Hopkins Hospital Bulletins are printed by Messrs. JOHN MURPHY & CO., Baltimore, from whom single copies may be obtained; they may also be procured from Messrs. CUSHING & CO. and the BALTIMORE NEWS COMPANY. Subscriptions, $1.00 a year, may be addressed to THE JOHNS HOPKINS PRESS, BALTIMORE; *single copies will be sent by mail for fifteen cents each.*